THE ENGINEER

FEBRUARY 19, 1954

Atomic Energy Authority

DETAILS of the Government's proposals for transferring the responsibility for the development of atomic energy were given in a Bill presented in the House of Commons last week by Sir David Eccles, the Minister of Works. The Bill embodies the scheme outlined in the White Paper (Command 8986, which was summarised in our issue dated November 13, 1953), dealing with the future organisation of Great Britain's atomic energy project under the direction of the Lord President of the Council. It provides for the establishment of the United Kingdom Energy Authority, consisting of a chairman and not less than six nor more than ten other members. Sir Edwin Plowden, it will be recalled, has already been designated chairman. Three of the remaining members of the Authority are to be persons of wide experience in atomic energy, and one other member is to have experience of administration and finance. The Authority is empowered to "produce, use and dispose of atomic energy and carry out research into any matters connected therewith," to arrange with "universities or other institutions or persons for the conduct of research into matters connected with atomic energy or radioactive substances" and to distribute information relating to these matters. While the Authority may conduct experimental work directed towards improved explosive nuclear assemblies for atomic weapons, it may not develop or produce any weapons or parts of weapons except by arrangement with the Minister of Supply. Similarly, the Authority may not search for materials in the United Kingdom except under the authority of the Lord President of the Council.

Electro-Heat and Prosperity

THE Faraday Lecture of the Institution of Electrical Engineers was delivered in London at the Central Hall, Westminster, on Tuesday, February 16th, by Mr. O. W. Humphreys, B.Sc., F.Inst.P., M.I.E.E., director of the research laboratories, The General Electric Company, Ltd. The Lecture was entitled "Electro-Heat and Prosperity," and it dealt with modern methods of generating heat electrically and applying it to industrial processes. With the help of demonstrations and films Mr. Humphreys described electrical radiant heating as applied to the drying of paint or the softening of plastics; high-frequency heating for the hardening of steel or the setting of synthetic glues; electric furnaces with special atmospheres for the heat-treatment of metals; and modern methods of firing porcelain and of joining metals by furnace or high-frequency brazing or argon arc welding.

Future of British Coal

AT a meeting in London last week, arranged by the French Chamber of Commerce in Great Britain, Sir Hubert Houldsworth, chairman of the National Coal Board, spoke about the future of British coal. He made a passing reference to the proposals for a closer association between the United Kingdom and the European Coal and Steel Community, pointing out that British coal output was roughly equal to the coal output of the Community as a whole, and that it came from at least as many separate and distinctive coalfields as the Community's coal. There were problems, Sir Hubert said, which this country and the Community had in common. It must be remembered, for example, that any development in coal production was inevitably a long-term proposition, and one which could not be proved or disproved with accuracy except over a period of decades. Sir Hubert went on to express the view that coal would continue to be the main fuel and energy basis for several generations to come, and that all this country's coal resources which were at present considered to be "economically workable" would, in fact, have to be worked sooner or later. Eventually, maybe, Sir Hubert continued, atomic energy would replace coal as the principal provider of energy, but even if it did, a very long period of time was still bound to elapse before such a state of affairs came to pass, and, even then, coal in large quantities would still be needed as a raw material for carbonisation and chemical processes. The danger, Sir Hubert thought, was that atomic energy would not come soon enough to take the load off coal.

Safety in Ironfoundries

THE Council of Ironfoundry Associations has set up a special committee to co-ordinate and intensify the efforts at present being made throughout the industry to keep down the accident rate in ironfoundries. Many of the hazards in foundries are, of course, common to other industries, but the number of special risks arising from the use of hot metal increase the complexity of the problem. In the years since the war, accident prevention has been given steadily increasing attention by employers and workpeople in the ironfoundry industry, and many of the larger firms have their own safety organisations. In smaller concerns, the personal attention of the proprietor or managing director is often the most effective method of securing satisfactory safety results. The Council says that the question of accident prevention has been further stimulated by the growing number of common law claims for damages for injuries, many of which the employers regard as at least originating in the neglect, sometimes shown by workpeople, to take advantage of the protective facilities offered. One of the problems still to be solved is how to encourage every foundry worker to make full use of the clothing and other equipment which is provided for his protection. The chairman of the newly appointed committee is Mr. C. Gresty, of the North-Eastern Marine Engineering Company (1938), Ltd.

Progress of the European Economy

THE fifth annual report of the Organisation for European Economic Co-operation was published at the end of last week. It contains chapters examining generally the situation and economic problems of each of the member-countries and countries associated with the work of the Organisation, and also surveys the prospects of and the problems involved in an expansion of production in Western Europe. In 1952, the report notes, industrial production in Western Europe barely exceeded that of 1951, and in the second quarter of last year production was only 4 per cent above that of the second quarter of 1951. This moderate increase, the O.E.E.C. says, was largely a reflection of increased output in Western Germany. There was some improvement last autumn, though in some of the main industrial countries, especially France and Belgium, industrial production was still below the levels attained at the peak of the post-Korean boom. The report goes on to explain that most countries experienced a minor decline in activity at some time in late 1951 or in 1952. It first affected the consumer goods industries, which, it is stated, had recovered in part by the end of last year. Later, the heavy industries were affected, the output of the basic metal industries in the period April to September, 1953, being about 5 per cent below the 1952 level. On the other hand, building construction has continued to expand in various countries. The report makes the comment that some of the obstacles to a sound expansion of production in Western European countries appear to have diminished during last year, the inflationary trends of recent years having disappeared.

A Foundation Problem

THE various problems encountered during the construction of the foundations of a multi-storey building in Singapore were described in an interesting paper presented at the Institution of Civil Engineers last Tuesday. The paper was entitled "The History and Construction of the Foundations of the Asia Insurance Buildings, Singapore," and the author was Mr. W. J. R. Nowson. The site of this building overlies an old beach, with decomposed shale and sandstone below it, and the original borings gave indication of firm sandstone at depths of 30ft to 42ft. It was therefore decided to sink a number of reinforced concrete cylinders to bear on the rock stratum, with bearing pressures up to 10 tons per square foot, and to connect them together with a reinforced concrete raft at column base level. Trouble was experienced in sinking the cylinders, and it was eventually determined that the expected firm sandstone stratum consisted of core boulders. A reconsideration of the foundation design at this stage indicated that it was necessary to reduce the bearing pressure to 3½ tons per square foot. The method adopted was to "bell out" the bases of the cylinders by the successive addition of rings of bolted precast concrete segments. The cylinders were first back grouted, and various kinds of segments were utilised, with sloping circumferential faces, or, alternatively, a longer upper flange bolted to the shorter lower flange of the ring above, to achieve the "belling out" effect. In some cases the cylinders were underpinned through the beach formation, using compressed air. On completion of the underpinning the shafts were sealed with a reinforced concrete slab, and a lining was cast inside the segmental rings. Finally, the tops of the cylinders were trimmed to level and a 4ft thick reinforced concrete raft was cast over them, to take the columns of the building.

Street Lighting and Road Safety

THE effect of street lighting on road safety was the subject of a Press conference held by the British Electrical Development Association in London on Monday, February 15th. The principal speaker was Mr. W. Robinson, who referred to some of the points brought out by the Association's street lighting committee as a result of a recent study of official road accident figures from 1945–52, with special reference to the hours of darkness. This study showed the greater severity and the higher rate of accidents at night-time. For example, the number of adult pedestrian fatalities per hour at night were two and a half times as heavy as during the day. The effect of darkness was strikingly illustrated by the change from summer time to G.M.T. in October. As shown by the figures for 1951, 1952 and 1953, there was very little difference in the number of fatal accidents to adult pedestrians in September and in October by daylight; but by night over the same period, the number of adult pedestrians killed increased by no less than 70 per cent. The effect of darkness was further emphasised by a study of the accident figures for November, December and January, when the afternoon traffic peak falls after daylight hours while the corresponding morning peak occurs during daylight. During these three months (in 1945–52) the night-time fatality rate for adult pedestrians was found to be three times the daylight rate. The B.E.D.A. study emphasised the relationship between poor visibility and a high accident rate and suggested that, by modernising street lighting and making use of existing lighting equipment and technique, the night-time accident rate could be reduced to nearly the day-time rate.

SPALDING FLOOD ALLEVIATION CHANNEL ON THE RIVER WELLAND

Fig. 6—Excavation of By-pass Channel

Fig. 7—Part of Completed Channel

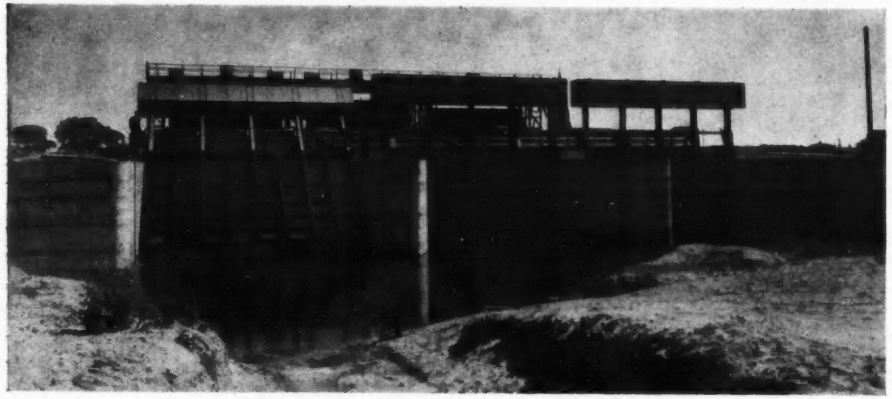


Fig. 8—Cycloidal Tidal Gates at Downstream End of Channel

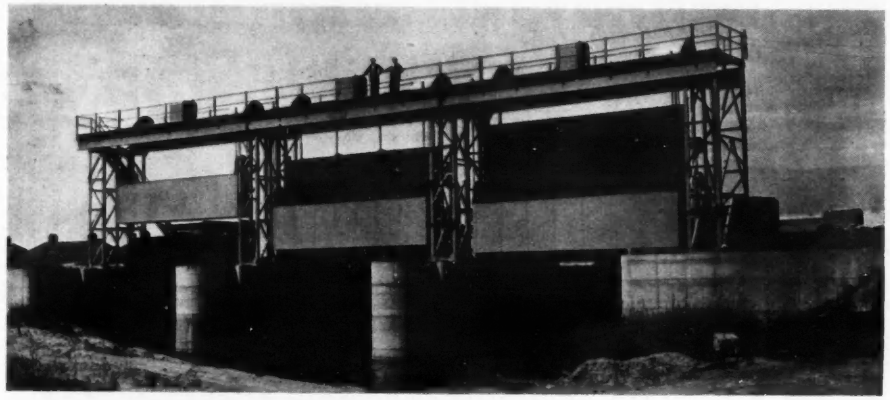


Fig. 9—Vertical Lift Gates at Downstream End of Channel

Flood Control Works on the River Welland

No. II—(*Concluded from page 236, February 12th*)

The River Welland major improvement scheme envisages a number of civil engineering works to increase the run-off capacity of the river, so that floods in the Welland and River Glen can be safely handled. One of the major works of the scheme, the Spalding by-pass channel, was inaugurated last September; other elements, principally flood relief channels in the upper Welland and from the Glen to the Welland will not be completed for two or three years.

THE importance of the Spalding by-pass channel in relation to the Welland scheme as a whole has already been explained. The channel, with its various ancillary works, cost about half a million pounds to construct. Its total length is 2 miles and it has sluice gates and bridges at each end and six other bridges along various parts of its length. A typical cross section through the channel was shown in Fig. 4 last week, and part of it is shown under construction and completed in Figs. 6 and 7. Berms are built on the inside of each bank; they serve to strengthen the toe of the bank and prevent slips, and also for access for maintenance. The berms are generally at +12 O.D. and vary in width from 12ft to 18ft. About 2000 yards of the channel was driven through soft grey clay containing organic matter, overlain at the surface by 3ft of firm brown clay. Vane tests were carried out in the soft clay by the contractor's soil mechanics department, and from the results of these tests the embankment design with 1 : 3 slopes and an 18ft berm was computed to have a factor of safety of 1·25 with the channel empty and 1·36 with it full. In the rest of the excavation fine silty sand was encountered, and it was possible to steepen the slopes to 1 : 2, keeping the berm the same size and the factor of safety about the same.

The two sluice gate structures and the various bridges are all carried on precast reinforced concrete piles. Generally the piles are about 14in by 14in in cross section and 30ft to 45ft in length; they are friction piles. A siphon was built, in reinforced concrete, under the channel to drain that portion of the South Holland Drainage Board's area cut off by the channel.

The largest of the structural works is the Marsh Road bridge and sluices, at the downstream end of the channel, where there is a set of three vertical lift sluice gates to control the channel flow, each 30ft wide by 19ft deep, and then a set of three cycloidal gates, each 30ft wide by 18ft deep, to prevent the access of tidal waters into the channel. The road bridge is built between these two sets of gates; it carries a secondary road 33ft 6in wide and is of three spans of 30ft each. The spans are simply supported with a vertical joint between each pair of them, so that some differential settlement may occur. This construction is also used on the other bridges of the scheme. The bridge spans are of reinforced concrete beam and slab construction, as are the sluice platforms.

The two sets of gates and the bridge were built as one unit, inside a steel-sheet-piled cofferdam, 156ft by 132ft in size. The footings were carried down to −7 O.D., in running silt, and well-point dewatering plant had to be employed. About 450 piles were driven in the cofferdam. The floor of the sluiceways and apron is of mass concrete and is 5ft thick, and the walls and abutments are gravity walls of mass concrete.

At the other end of the by-pass channel the Cowbit road sluices and bridge were built in a very similar manner, within a cofferdam, and with dewatering plant. There is only

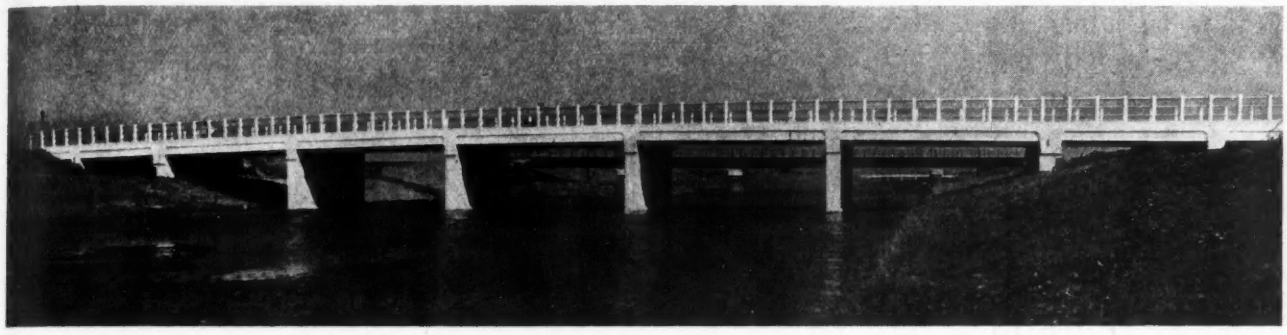


Fig. 10—Cunningham's Drove Bridge

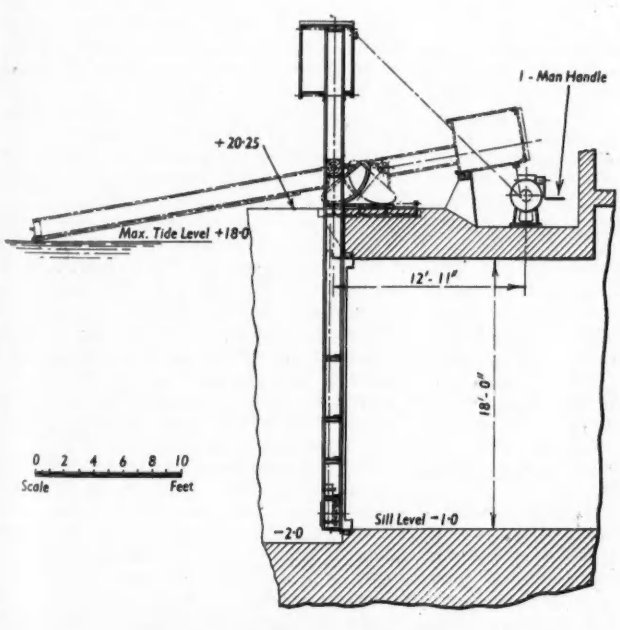


Fig. 11—Cross Section of Cycloidal Gate

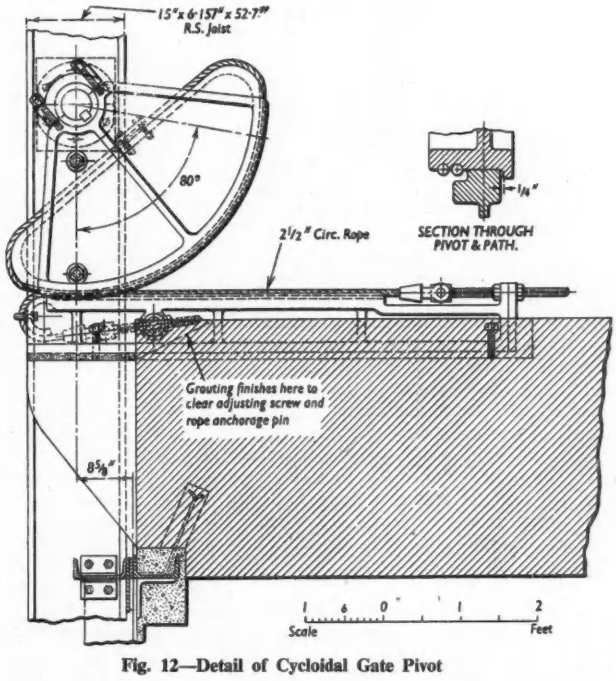


Fig. 12—Detail of Cycloidal Gate Pivot

Fig. 9—Vertical Lift Gates at Downstream End of Channel

one set of sluice gates in this structure, however, consisting of three vertical lift gates, each 30ft by 19ft in size. The bridge has three 30ft prestressed concrete spans.

The various other bridges across the channel are all somewhat similar in span and design, except for the steel railway bridge and Pecks Drove bridge, which consists of three 80ft spans of double/single Bailey bridge units. The other four bridges are of reinforced concrete flat slab construction, the largest of them—Cunningham's Drove bridge—has nine spans and is 292ft long. It is illustrated in Fig. 10. The railway bridge

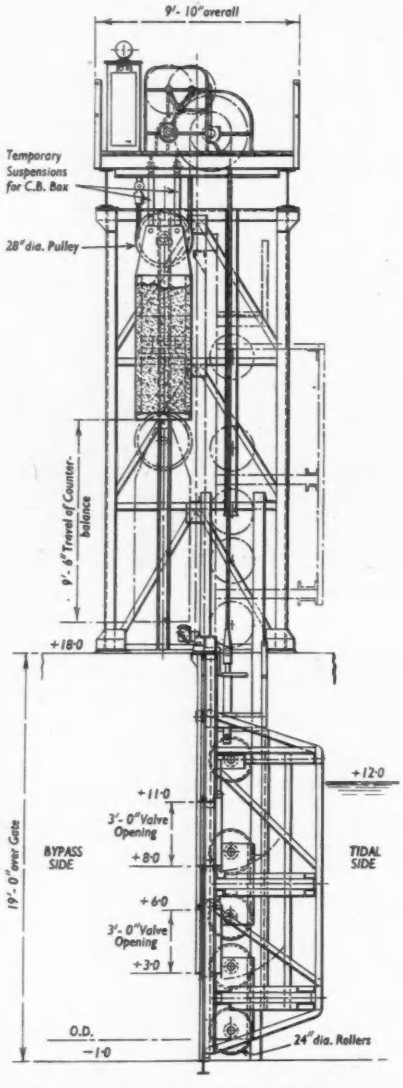


Fig. 13—Cross Section of Vertical Lift Gate

is a steel girder structure, 271ft long with five spans, and can be seen in the background of Fig. 10 ; it is 9ft above the level of the original track, and whilst construction of the by-pass channel was in progress a temporary diversion track $\frac{3}{4}$ mile long had to be laid and maintained. The bridge is approached by embankments which extend for about $\frac{1}{2}$ mile on each side of it.

Just upstream of the by-pass channel the river has been widened by constructing two steel sheet pile retaining walls for a length of 820 yards, through a built-up area. The piles are secured by tie rods and anchor blocks.

By-pass Channel Sluice Gates

The cycloidal gates at the downstream end of the flood alleviation channel are something of an innovation, in that they are an unusually large installation for this particular kind of gate. Cycloidal gates, often constructed with a toothed worm wheel sector on the gate turning on a fixed rack, have been used for many small tidal outlets, and it is claimed that they are more sensitive in action than simple pivoted gates. The three gates at Marsh Road each span 30ft and are 18ft deep, and each one rolls on five pivots ; the pivots are semi-circular and run on fixed rail paths and the gate is held in position at each pivot by the wire rope and anchorage arrangement shown in Fig. 12. The general arrangement of the gates is apparent from Fig. 11. They are of mild steel bolted and riveted construction, with machined steel staunching strips bearing against similar machined strips on the sill and the sides of the sluiceway when the gate is closed. Each gate comprises a frame of nine vertical 15in by 6in by 52·7lb steel joists, and horizontal angles, 6in by 3in by $\frac{3}{8}$in, carrying the $\frac{1}{2}$in plate skin, framed at top and bottom by 8in by 3in by 18·7lb channel sections. Alternative vertical joists are carried up to the pivots and the balance box at the top of the gate. Two 12in bore hand-operated scouring valves are built into each gate. The balance box is of similar construction to the rest of the gate, weighing about $6\frac{1}{3}$ tons and requiring $16\frac{1}{2}$ tons of sand for ballast ; the weight of the gate is $12\frac{1}{2}$ tons.

These cycloidal gates, as may be seen, are very simple in their principle of operation yet they are sensitive to very small differences in level, and will open under a head of the order of a few inches. They may be pulled open manually by the hand-operated winch shown in the drawing. Their general appearance is shown in Figs. 8 and 14 ; in these illustrations the installation of the gates is complete, but excavation of the adjacent lengths of the by-pass channel had not been undertaken at the time the photographs were taken.

With the security of operation required for the flood channel it was considered essential to have two sets of gates in series at the outlet. The second set of gates at Marsh Road, one of which is shown in cross section in Fig. 13, are vertical lift gates of more conventional design than the cycloidal gates. This second installation is illustrated in Fig. 9, in which two of the gates are shown in the raised position, with their balance boxes in front of them. The gates are electrically operated from a winch house built on the bank close by, the braking equipment fitted being effective in both directions of operation. Fig. 13 shows that each gate rolls on ten rollers, five at each side. The lowest pair of rollers, and the next pair above, are each mounted on bogies, which are carried on the gate girders ; this arrangement ensures direct transmission of load to the roller paths and an equal load on each of the two rollers of a given bogie. Only one roller is necessary at the top of the gates, where the hydrostatic load is less. The gates are of the same effective size as the cycloidal gates and there is a similar installation of vertical lift gates at the upper end of the by-pass channel.

A 4 h.p. motor (400V, 50 c/s, three-phase) is fitted on the gantry for operating each gate, giving a lifting speed of 3ft per minute, corresponding to a lifting time of $6\frac{1}{3}$ minutes ; a 14in handle is also provided for manual operation at two speeds. Concrete filling is used for the counterbalances, 28 tons being necessary for the centre gate and slightly less for the other two. These gates were designed to withstand a head of 18ft on either side, and to be operated with a load of 18ft on the by-pass side (i.e. no water on the tidal side) or with a maximum head of 1ft on the tidal side, with the tidal water not higher than +12 O.D. Scour valves are fitted in the centre gate only, and the piers between the gates are, as for the cycloidal gates, 7ft wide.

River Widening

The extent to which the river has been widened and the embankments heightened will be apparent from an inspection of the various cross sections shown in Fig. 4 *ante*. The basic tool for this work is the dragline, which both excavates and shapes a new embankment. It may be noticed that in places the bed of the river has been moved over so as to leave a protective berm at the toe of the important flood banks. For instance, the Deeping bank has been provided with such a berm for some considerable length. Where such a construction was not possible the bank has been strengthened by placing extra material at the back of it, either from the river excavations or from a borrow pit, dug as a drain, a soke dyke as it is called, behind the bank. Figs. 2 and 3 *ante* showed the Welland at Crowland bridge before and after improvement. In the first illustration the old river channel is in the foreground and the second channel has been excavated as the first stage of the new works. In the second illustration the river is flowing in the new channel and the protective berm can be seen in front of it, along the old course of the river. Work is still in progress along the river by Crowland Wash, but the widening works are now substantially complete, as far upstream as Folly River. The Maxey new cut and the Glen cut from Market Deeping to Greatford will be constructed within the next three years to complete the scheme.

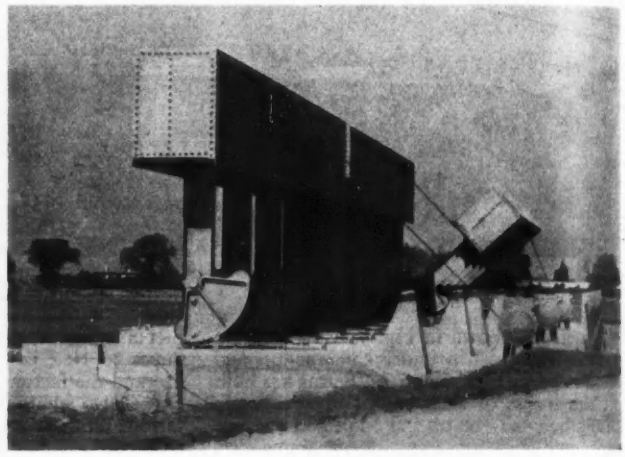


Fig. 14—Pivots and Balance Boxes of Cycloidal Gate Installation

The river widening works alongside Cowbit and Crowland Washes have involved the construction of a road bridge—the main spans are to consist of precast prestressed concrete beams—which is at present being built, two concrete weirs to control any future spilling into the Crowland and Cowbit Washes (which might possibly occur under very exceptional circumstances) and a footbridge at Four Mile Bar. The footbridge was

illustrated in Fig. 5 *ante* ; structurally it consists of pairs of joists, each spanning 30ft, with a jack arch formed in concrete between them carrying the footway. The bridge has four spans.

The various works of the scheme have all been carried out under the direction of the Welland River Board, whose chief engineer is Mr. E. G. Taverner. Some of the works have been constructed by direct labour and others by contract ; the various sections, together with the contractors who built them, are listed herewith :—

Spalding flood channel : main contractors, George Wimpey and Co., Ltd.; design and manufacture of sluice gates, Ransomes and Rapier, Ltd.; main contractor for all the by-pass channel bridges, W. and C. French, Ltd.; additional contractors for railway bridge, The Butterley Company, Ltd. (steelwork) and the Eager Construction Company, Ltd. (temporary diversion).

The remainder of the work has been divided up as follows :—Fosdyke bridge to Surfleet (i.e. tidal excavation and flood banks in the estuary), 45,000 cubic yards of excavation, George Wimpey and Co., Ltd.; Surfleet to Fulney, 1,250,000 cubic yards of excavation, The Butterley Company, Ltd. These two contracts covered the length of river below the by-pass channel. Above the by-pass channel the steel sheet piling contract from Cowbit Road bridge to Locks Mill was carried out by W. and C. French, Ltd.; Locks Mill to Crowland Bridge, widening totalling 1,500,000 cubic yards of excavation was by direct labour, including the Four Mile Bar footbridge and the two weirs. Crowland Bridge is being built by W. and C. French, Ltd. Widening from Crowland Bridge to Folly River is also being carried out by direct labour, as was the outlet channel to the Wash below Fosdyke Bridge. Two reinforced concrete bridges on the proposed Maxey new cut, which were destroyed in the 1947 floods, have been built to the new requirements by Dowsett Engineering Construction, Ltd.

Messrs. Stirling, Lambert and Partners, of Peterborough, were consulting engineers for five of the new bridges constructed across the by-pass channel. Rendel, Palmer and Tritton acted as consultants for the new railway bridge. The remainder of the bridges, the sluices and the steel piling were designed by the River Board's staff.

French Locomotive Experiences

By EDWARD H. LIVESAY

No. I—" THE GOLDEN ARROW," LONDON/PARIS

PART I—VICTORIA/DOVER

"AN opportunity once missed never recurs "—a depressing aphorism which, however, loses much of its sting when slightly modified by substituting the word " seldom " for " never "—Providence does sometimes allow a second chance. But woe betide the beneficiary if he again fails to take advantage of the concession, and on this conviction I have acted recently, the following articles being the result.

Going back to the beginning, in 1939 the former editor of THE ENGINEER enquired if I would care to go to France and do some running on Chapelon locomotives, which had been putting up remarkable performances for several years, rousing keen interest in the locomotive world. The suggestion naturally appealed to me and, after a little hesitation, was agreed to, arrangements being made with the Société Nationale des Chemins de fer Français—S.N.C.F. in future, for short—for me to cross the Channel in September of that year and report on the work of representative French locomotives. However, it will be within the recollection of readers that another individual, the late unlamented Adolph Hitler, began an extensive Continental tour the same month, and our respective plans clashing, mine had to be abandoned—as I thought, probably for good. Time and the war inexorably marched on ; I was no longer in England and for the time being too much engaged to visit either Britain or France ; the occupation, invasion and their aftermath had disrupted the French railway system, disorganising it and damaging motive power to such an extent that it would probably be many years before the S.N.C.F. would again be in a position to re-establish the *status quo* and reintroduce the fast and heavy trains with which the Chapelon locomotives had been associated, and the talented designer's name inseparably connected. It even seemed doubtful if things ever could be the same as before, or any serious effort made to restore them. At any rate, this is how it looked to me, so for several reasons it seemed unlikely that a second opportunity of making the excursion would present itself, and I had more or less resigned myself to this probability when I was proportionately surprised and grateful to Providence—in the guise of the present editor of THE ENGINEER—to find, when I was in England, in 1952, that the original idea had been taken out of its pigeon-hole and was being again presented to me. Moreover, I felt justified in accepting the assignment, notwithstanding the passage of the years and certain faint qualms as to my ability to do justice to it—which the editor was kind enough to pooh-pooh. Thus, after due consideration, the clock was set back thirteen years and restarted : the result was the following record of what I saw during a month spent in France, while covering several thousand kilometres on a variety of exceptionately interesting locomotives.

It should be made clear at the outset that the editor is not responsible for the programme. I am the guilty party—in collaboration with Monsieur Chapelon. A " blanket " authorisation having been obtained by the editor from Monsieur Parmantier, Chief of the Department of Material and Traction, he—the editor—somewhat trustfully, I thought, not to say recklessly, thereupon turned the whole thing over to me, giving me a free hand to arrange the subsequent proceedings in my own way. This, though certainly simplifying matters in some degree, put me right " on the spot," as it were, leaving it up to me to make good. Recognising my own limitations but not admitting them openly, I straight away approached Monsieur André Chapelon, Chief of the Department of Locomotive Design, for his advice and assistance, explaining roughly what I had in mind, and requesting that he would be good enough to choose a number of representative locomotives, steam, electric, diesel, on which I might travel ; engines engaged in a variety of duties, express, local, freight and so on, which would together enable me to paint a comprehensive picture of what was being done on the railways of post-war France. To this Monsieur Chapelon courteously acceded and he, therefore, is responsible for the selection of engines and services dealt with in these articles ; I merely did my best to render justice to the material so lavishly provided. This being so, it was unfortunate that I did not have the pleasure of meeting Monsieur Chapelon, he being on holiday, but he had left directions with his able staff that I was to be given every facility to see what I wanted to see, and that all associated information should be given me, and I could not help noticing from beginning to end how thoroughly and generously his personal assistants, Monsieur George Bohl and Monsieur Segaud, and their assistants, gave effect to these instructions. Nothing seemed too much trouble to anyone. I was continually at a loss for words—literally, not being able to speak French !—to express my appreciation for all that was done, and for means to repay it in kind. In short, everyone, from the " brass hats " right down to the humblest *mécanicien* or *chauffeur*, did his best to help and make my association with them and the S.N.C.F. fruitful and pleasant. And they succeeded ; but I am getting ahead of the game—it will be evident enough as the story unfolds and I shall refer to it again more than once.

Naturally, I like to think these contacts were mutually agreeable and I believe they were.

I have already admitted feeling a certain measure of apprehension at undertaking this tour, but only one thing really gave me serious concern—to say the least, I am not on very familiar terms with the French language. I can read it—with deliberation and a dictionary—but as to speaking it or understanding it in reverse, or when further complicated, as it inevitably would be, by the rack and roar of a locomotive in full flight, the task would be hopeless. So it was essential that there should be somebody with me on the footplate to act as interpreter, as, failing this, I should miss so much and misunderstand so much more, that I might almost as well stay at home. I confessed this disability in the preliminary correspondence with Monsieur Chapelon, and it is hardly necessary to say that it was taken into full consideration, an interpreter—usually the equivalent of a British locomotive inspector, thoroughly *au fait* with the particular class of engine on which I happened to be riding—was always provided, except when I went off " on my own " on a joy-ride, which did happen when I got used to things, and discovered how charming French enginemen could be ! I was very grateful to these couriers, for this is what they actually were, interpreting their duties as implying far more than mere interpretation. Nobody could have been kinder or more helpful than these officials invariably were, their company in the cab going far to ensure the success of every run, to say nothing of its enjoyment. With them I was carefree and at peace with the world—without them I should have been hamstrung, an irritable nuisance to myself and everybody else, and should probably have thrown up the whole thing in disgust. Several became and remain friends, with whom I shall renew association in the not distant future. But once more I am getting ahead of the game ; I am apt to do this whenever I recall the kindness shown me in France !

It was arranged that the programme

was to open with "The Golden Arrow" which has been handled for many years from Calais to Paris by four-cylinder compound "Pacifics," both older rebuilt classes and others of more modern construction, and the war intervention has made no alteration. On this side of the Channel it is now worked by the Standard "Pacifics" from Victoria to Dover,* and as I had only ridden these fine engines a few hundred miles and not at all on important trains, it seemed worth while to make the inaugural run begin in London, which would have the additional advantage of making a comparison between the work and running of the French and British opposite numbers possible. Thanks to the courtesy of the Railway Executive, this was also arranged, and No. 70,004, "William Shakespeare," was rostered for the occasion. It will be remembered that this engine was exhibited at the Festival of Britain, and that shortly after it went into service it broke a connecting-rod—I believe while hauling "The Golden Arrow"—and that subsequently the class was withdrawn for a while in order that certain detail alterations and improvements might be made, though this may have been coincidental, and not primarily due to "William Shakespeare's" misfortune. I think it is correct to suggest that the things most needing attention were (1) the connecting and side-rods, (2) the driving axles, and (3) the draw-gear between engine and tender. I shall have a little more to say about these matters later, which makes the following paragraph *apropos*.

At the beginning of these articles I would like to touch on a somewhat personal matter, because it has a bearing on the series as a whole—I merely wish to say that I am not a "Yes-man"! I have always tried to record facts, as I saw them; the truth, though admittedly not always the whole truth, which is not always advisable. These articles will be no exception. I intend to set forth what I saw, good or otherwise. The articles will be factual, or they would be worth neither writing nor reading, and I hope to make them both. I say this unequivocally at the outset, because it was suggested in THE ENGINEER recently—not by the editor, incidentally—that accounts of locomotive experiences were seldom "true to life," as they were inevitably coloured by the necessity of paying deference to the powers that be, presumably on the principle, "Kiss the Son, lest He be angry, and ye perish from the right way!" There may be a substratum of truth in this as applying to some people, but it certainly does not apply to me. I do not go in fear and trembling of the Railway Executive, who have always treated me very kindly, and who are, I am sure, too broadminded to object to the presentation of facts in the technical Press, even though these may not always be entirely favourable—there is no such thing as perfection. Personally, it happens that on arrival in England, I took up this very point with the Executive—that is, the desirability of permission being granted to draw attention to what I noticed on my peregrinations without fear or favour, and I was assured that no objection would be raised to my so doing. Later, I was very agreeably surprised at the latitude allowed me, which went beyond what I had looked for. Naturally, there are limits outside which an observer should not stray, if only to avoid making trouble for people who may not be in a position to defend their actions, or might even lack the ability to do so. After all, I am a guest, and a guest does not accept hospitality and then pick his host and his house to pieces. So, within reasonable limits, I hope to make these articles as far as possible an unvarnished record of what I saw and experienced on French metals—and on the preliminary British pair—and I am sure this will meet with the approval of both the S.N.C.F. and B.R.

Looking round No. 70,004 before the start, I noticed that the coupling rods between the first and second driving axles were now of rectangular section, instead of fluted, as they had been originally, and generally are; the connecting-rods remained fluted, though I understand several variations had been tried and different web and flange-thicknesses experimented with. Some time ago it was suggested in THE ENGINEER that the excessive slipping of which the class had been accused—in my experience unjustly—might be due to the fitting of roller bearings! Rather a quaint theory; I do not see how there could be any possible connection; the trouble, if it ever existed, would be far more likely to result from careless handling of the regulator or having one that does not permit delicate initial opening. As to slipping with the regulator shut, I would like to see a logical explanation of it before believing it. I noticed, too, that No. 70,004's hollow driving axles had been plugged, the plugs extending to the inside of the axleboxes, I was told. An unusual "teething trouble" this—I refer to the loosening of the driving wheels on the axles, which occurred on certain engines of the class—the plugs were inserted to prevent it. Could it be due to overdoing the hollowing of the axles? On my first trip on a "Britannia" the large size of the bore had attracted my attention.

"The Golden Arrow" (Fig. 1) pulled out of Victoria at 11 a.m. in fine weather, with its usual load, rather under 400 tons, though there was a strong side wind blowing; there was no slipping whatever on this occasion. The crew were enginemen Durrant and Pevyman, of Dover; there was another man in the cab, too, acting as instructor to the fireman, who was making his first trip on a "Britannia." The regulator was two-thirds, cut-off 40 per cent, and steam

Fig. 1—"Golden Arrow" Leaving Victoria Hauled by "Britannia" Class Locomotive

* Since the author's journey the destination on the Channel of the Golden Arrow train has been changed to Folkestone. —ED. THE E.

240 lb, but the steam chest gauge needle was flickering so badly as to be unreadable. Needless to say, there was no speed indicator ; I shall never cease complaining of this omission—there ought to be one, at any rate on an express engine. A speedometer is as necessary on a locomotive as on a motor-vehicle and often more so. In the absence of this tell-tale all my speed figures are approximations, near enough to actuality for practical purposes ; I refuse to fiddle about with a stop-watch on the footplate when there are far more interesting things to attend to ; it might become an obsession, as it has with some people ! Acceleration was good, the engine taking the many sudden and often heavy gradients that distinguish this route well ; it is certainly the worst of all the railway exits from London, as the profile (Fig. 2) shows. The 1½-mile climb at 1 in 101 from Herne Hill through West Dulwich to the entrance of the long Sydenham Hill tunnel was taken at 25/30 m.p.h. ; a drop then begins at 1 in 330 and once inside, the engine picked up speed fast, blowing off triumphantly. We emerged doing 50 m.p.h. until the brakes went on for the steepening 1 in 101 downward mile through Penge East to the foot of the incline at Kent House, where another long but less severe rise begins, continuing to Shortlands Junction. Shortlands Station follows close ; it was passed at 11.19 and we were checked down to 25 m.p.h. Ten miles from a standing start, saw-tooth profile and frequent curvature, one thing after another and repeat—very satisfactory and far from easy, all things considered. This is certainly a nasty stretch to negotiate with 400 tons.

The riding and general behaviour of No. 70,004 were good, far better than had been the case with " Ariel," on which I had made my first trip with a " Britannia " out of Leeds to Glasgow some months before. Previous to this, in an interesting talk, Mr. Riddles had warned me that the riding would be unsatisfactory, and I should not pay too much attention to it. The engine/tender coupling was going to be altered as, in an attempt to simplify things, the side buffers had been omitted, but this had proved a mistake and they were going back again. The worthy aim, simplification, had been overdone here, admittedly, " Ariel's " tender riding badly, and this evidently affected the engine's action, too. (This is an example of the outspokenness in which I hope to be allowed to indulge in these articles, as previously forecasted !) When the " Britannias " first went into service complaint was voiced in some quarters that they caused rough riding in the first coach of the train and various explanations, more or less windy, were advanced to account for this. If this was so, I suggest the real reason was probably the absence of side control from the engine/tender coupling gear, as pointed out. " William Shakespeare " had these buffers and the improved action of both engine and tender was unmistakable.

The main Charing Cross/Dover line was joined at Orpington Junction, in the middle of a long and very heavy bank beginning at New Cross, continuing with scarcely a break for 12 miles to the summit at Knockholt. The culminating climb of 2½ miles, mostly 1 in 120, through Chelsfield was taken at 30 m.p.h., with cut-off 30 per cent and the regulator, as usual, two-thirds. I like the arrangement of the reverse wheel, with its drum carrying the scale in big figures, right in front of the driver, which makes it very easy to read, but this, too, has disadvantages in the event of shafts or gears getting out of alignment, as they had done—or something of the sort—on another " Standard " I travelled with. The gear was very stiff to operate ; in fact, it was all the driver could do to move it and his language was correspondingly affected.

Knockholt summit, roughly 17 miles from Victoria, was passed at 11.32 ; then came a long drop of 4 miles to Dunton Green, the first 1½ miles 1 in 143 through Polhill tunnel, in which the speed rose until we emerged at 70 m.p.h., blowing-off vigorously ; Pevyman was evidently profiting from the instructor's advice. Then up 1½ miles of 1 in 160 to Sevenoaks ; down 2 miles at 1 in 144 through Sevenoaks tunnel, again flashing out into daylight at 70 m.p.h. ; as before, blowing-off—it seemed to have become a habit ! Continuing down an increasing declivity of 1 in 122 for 4 miles through Hildenborough, speed was checked nearing the foot on the approach to Tonbridge, passed 11.46, one minute late, at 35 m.p.h. ; yes, blowing-off ! Thirty miles in 46 minutes, which sounds unimpressive, but the route had been heavy : gradients, signals and restrictions had taken their toll, and the performance had been better than it looks. By far the heaviest part of the work had been done ; what remained of the route would give " William Shakespeare " a better chance to speed up. Steaming had certainly been good, with pressure well maintained up all the long and heavy climbs, but I could gather nothing about " front end " efficiency as the steam chest gauge had flickered crazily throughout the run and was still doing so. Every minute I expected to see the hand fly off the pin ; condensation in the pipe probably.

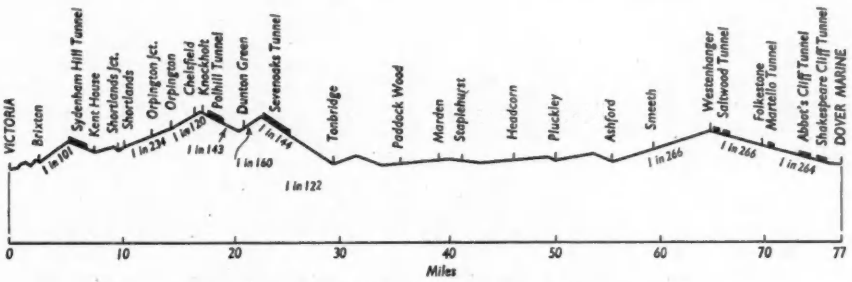


Fig. 2—Approximate Profile Victoria-Dover (" Golden Arrow ")

Following Tonbridge there is a succession of long straights along which the speed rose to 75 m.p.h. and over, the riding being noted as " good." Not, of course, that it was equal to an " A4 " or " Coronation " in " good nick " ; one could hardly expect this from a small-wheeled (74in), two-cylinder engine, but there was certainly nothing to complain of. The tender was particularly steady, very different to " Ariel's," which had " shimmied " so vigorously and persistently that coal cascaded out on to the footplate nearly all the time, to the embarrassment of the fireman and the inconvenience of myself—he did not want so much, and I did not want any—I was generally standing on a bed of it, or kicking lumps out of the way. " Why not shut the door ? " Because there wasn't one. I think there should be, and steps should be taken to prevent the irons sliding forward out of their shelf whenever the engine goes down hill, and jabbing the fireman in the back—that did not happen in France, and I will explain why in due course. Just little things, these, and there are one or two others about the " Standards " that need eliminating from the cab, well arranged though it is—but a number of little things can cause considerable querulousness on the footplate. I cannot help thinking that economy is being overdone somewhat on British railways, leading to the absence of some things on engines that ought to be there, whether we are " broke " or not—as a matter of fact, we are not. With " Major Barbara's " Cholly Lomax, " I can't help thinking there's a certain amount of tosh " about this economy plea ! There seems to be plenty of money available for non-essentials ; why not cut that down, and spend a little more on things that matter ? But this is a cliché —somebody made the suggestion before, I believe.

The extension of the footplate right back to the bunker is an admirable arrangement ; the crew have only one piece of more or less stable floor to adjust their footing to ; there is no flap-plate between engine and tender to cause trouble (*vide* " The Capitals, Ltd.," in the December 12, 1952, THE ENGINEER), or even actual injury. But it has brought with it a drawback that evidently was not foreseen by anyone ; neither the designer nor the enginemen, who, I understand, were consulted about footplate fittings and layout in advance of construction. A bad draught comes from under the cab, curling up the front of the bunker and forward, right on to the driver's back, and in lesser degree on to the fireman. All the enginemen have complained of it on every engine fitted with this arrangement on which I have ridden—" Pacifics " and 4–6–0s—and with reason. As some have pointed out, it does not matter so much in summer, but it does in winter ; lumbago, colds and other assorted ailments can result. Something should—and no doubt ultimately will—be done about it. I have thought of one or two remedies myself, which the Railway Executive is welcome to, merely for the asking ! But this just shows how an improvement made with the best intentions and at first sight impeccable, can bring unexpected trouble in its wake.

Down the long descending straight to Paddock Wood the speed rose to 75 m.p.h. plus, and again the good riding was noted. Marden, 11.56, Staplehurst, and still the track stretched ahead without deviation, the rails seeming to converge on a point in the distance—surely this must be one of the longest straights in Britain ? Headcorn, 12.01, average 46 m.p.h.; nothing very striking, and I recorded the figures not so much for their inherent interest, but to see how they would compare with the coming Calais–Paris part of the journey. At Pluckley the line began to rise again, but the speed remained high until it was brought down to 15 m.p.h. for a relaying restriction, after which it rose rapidly again, and Ashford, 56 miles, was passed at 50 m.p.h., rising, 12.14, and an 8½-mile climb began through Smeeth to the summit at Westenhanger, topped at 12.23, O.T., 8½ miles in 9 min, mostly at 266/342—a creditable effort, the best showing " William Shakespeare " had made yet. The 65 miles from Victoria to the Westenhanger summit had been covered

in 83 min, (47 m.p.h.); all the heavy part of the route was behind us, and from this point it was a straight-away downhill run to the finish, through sundry tunnels—Westenhanger, Saltwood, Martello, Abbott's Cliff and Shakespeare—and typically Kentish chalk cuttings, with the sea coming into the picture on the right, showing white horses raised by a strong westerly wind. "The Golden Arrow" emerged from the Shakespeare tunnel into bright sunshine—it had been dull until then—and the engine, which had been held well in hand all the way down the 11-mile descent from Westenhanger, with its speed gently reduced, rolled to a stand in Dover Marine Station at 12.36, 4 min late. These had been lost over the approaching miles through the "built-up" areas, and were partly due to a service slack controlling the last 1½ miles. The 77 miles from Victoria had been covered in 96 min, an average speed slightly over 48 m.p.h.

So much for the performance of "William Shakespeare" over the classic route from London to Dover. "There are milestones on the Dover Road," and even if the equivalent lineside mileposts did not flash past ultra-quickly, nevertheless the run had been better than the bald figures indicate. The first half of the route had been very heavy, unsuitable for high speed, and the last 15 miles came into the same category. Only the Tonbridge–Westenhanger section gave the "Golden Arrow" an opportunity to live up to its name. I have no serious criticism to lodge against either train or engine; there had been none of the slipping of which the "Britannias" had been accused. No. 70,004 had ridden and steamed well; in addition, neither connecting-rod had broken, and all the wheels had remained on their axles! Judging from the amount of blowing-off, Fireman Pevyman's first run on a "Britannia" must have been encouraging both to himself and his instructor; I am sure the "L" card did not hang in his cab very long. It had been a pleasant, carefree trip, under familiar conditions, through the Garden of England, with my own sort of people, who understood everything I said without an interpreter. But now it was over, and my spirits sank a little. I was about to take a plunge into the unknown, and did not feel entirely confident of my ability to handle things; there might be breakers ahead! How simple it would all be if only I could speak French! So thinking, I said "Goodbye" to the friendly crew, who wished me luck, and on getting down to the platform, I remarked, "Well, here's where my troubles begin!" and immediately, as if reproving me for my pessimism, the loudspeaker boomed out, "Will Mr. Livesay please go to the announcer's box on No. 4 platform?"—presumably where he will hear of something to his advantage, I thought, and so it turned out. A courteous British Railways official there took charge, guiding my ignorant steps through all the exit formalities to the purser's office on board the "Invicta." Thence, via the Bar, I proceeded to a comfortable cabin where I was told I could relax (and wash, implied), and await the call of a corresponding S.N.C.F. representative who would come for me at Calais. Feeling correspondingly optimistic, and grateful for all that had been done for me by the Railway Executive, I relaxed as directed—and this seems a suitable place for the reader to relax, too.

(To be continued)

Continental Gas Turbines in 1953

IN this article an account is given of the progress recorded in the design, construction and operation of gas turbines by the principal companies engaged in their manufacture on the Continent.

BROWN BOVERI AND CO., LTD., BADEN

On December 31, 1953, the number of stationary gas turbines built solely for industrial power generation, ordered from the firm of Brown Boveri and Co., Ltd., of Baden, Switzerland, amounted to twenty-five machines. Their collective terminal output was 155MW, the size of the units ranging from 1200kW to 27,000kW. Some of these turbines operate on heavy residual oil fuel, others on natural gas, one on blast furnace gas, while that for the Electricité de France, of Paris, a 6000kW gas turbine, which the firm has now under construction, will run on diesel oil fuel, and is being designed for a gas inlet temperature of 1380 deg. Fah. The forerunners of this latter set are all designed for, or operate at, lower gas inlet temperatures which do not exceed 1200 deg. Fah. The efficiency of the turbine units mentioned above ranges from 16 per cent to 34 per cent. Their uses may include base load operation, emergency and peak load services, and installations which demand quick starting.

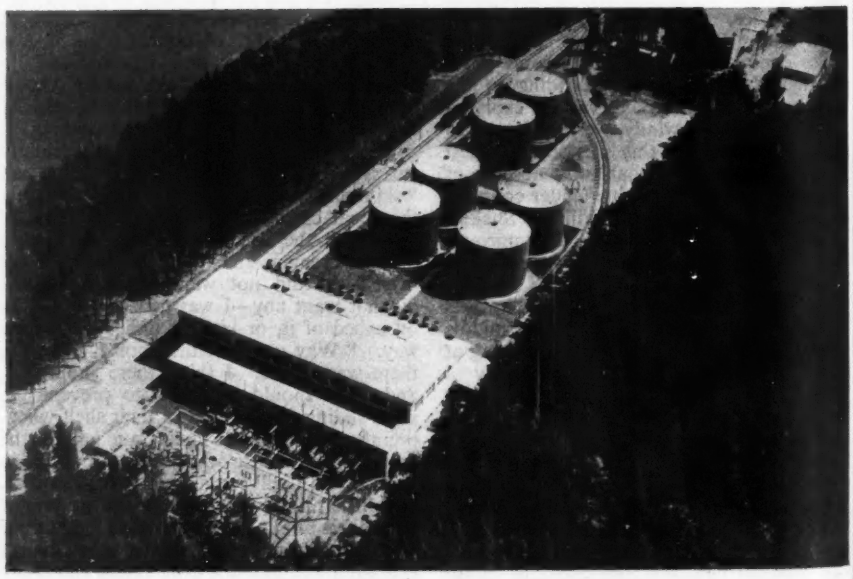
The firm has equipped two power stations, consisting solely of gas turbines, at Beznau, near Baden, and at Pertigalete, in Venezuela. The former station has one 13,000kW and one 27,000kW gas turbo-generator sets, and the latter, two 1650kW and two 5000kW sets. A further contract for the supply of a complete generating station to house three gas turbine generating sets, each of 6000kW capacity, has been entered into by the firm with the Saudi Arabian Government for the town of Jeddah.

As a result of the research work and developments which have taken place during the period under review, the firm of Brown Boveri will now be able to construct single stage compression with single stage combustion gas turbine generating sets, in sizes up to 10,000kW and 15,000kW and build sets up to 20,000kW-25,000kW by using two-stage compression with two stage combustion. Hitherto the limit for single stage units was approximately up to 6000kW-8000kW.

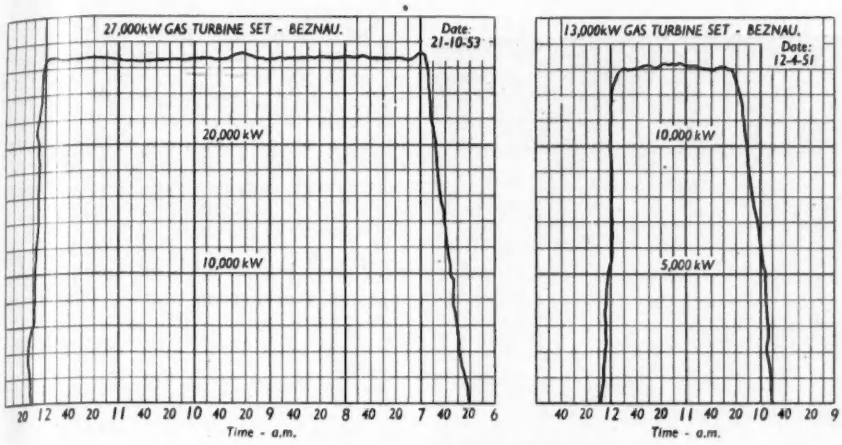
As the Beznau gas turbine power station of the Nordostschweizerischen Kraftwerk A.G. is the largest industrial plant of its kind in the world, it is of interest to show something of its general layout. In the accompanying illustration we reproduce the latest view of the complete station taken from the air. In the foreground will be seen the open-air switchgear and connections to the Company's overhead line with the transformers in the background. The buildings give accommodation for the two 13,000kW and 27,000kW sets and their auxiliaries. The exhaust uptakes, five in number for the smaller, and ten for the larger set, may be noted. There are six large oil fuel tanks which carry the full winter supply of fuel for the station, and the railway sidings for the station and the incoming and outgoing oil tank wagons will also be noted.

This 40MW gas turbine power station continues to run essentially as a winter peak load station. Its operation is clearly indicated by the day load diagrams we reproduce herewith, the left-hand diagram relating to the 27,000kW set and the right-hand diagram to the 13,000kW set. Another diagram shows the tabulated operating results since the inauguration of the Beznau station in January 1948, when the 13,000kW set was started up. The 27,000kW set was put into service in the following year, January 1949. The upper figures of the diagram show the monthly output in millions of units, while in the middle and lower parts of the diagram, the working hours for both the 13,000kW and the 27,000kW sets are given up to the end of December.

With the satisfactory results attained with stationary plants, Brown Boveri has continued to give attention to marine gas turbines. At the recent annual meetings of the Schiffbautechnischen Gesellschaft E.V., held in Hamburg from November 18th to 21st, an interesting paper was presented by Dipl.-Ing. Wehrlin of Baden, in which he



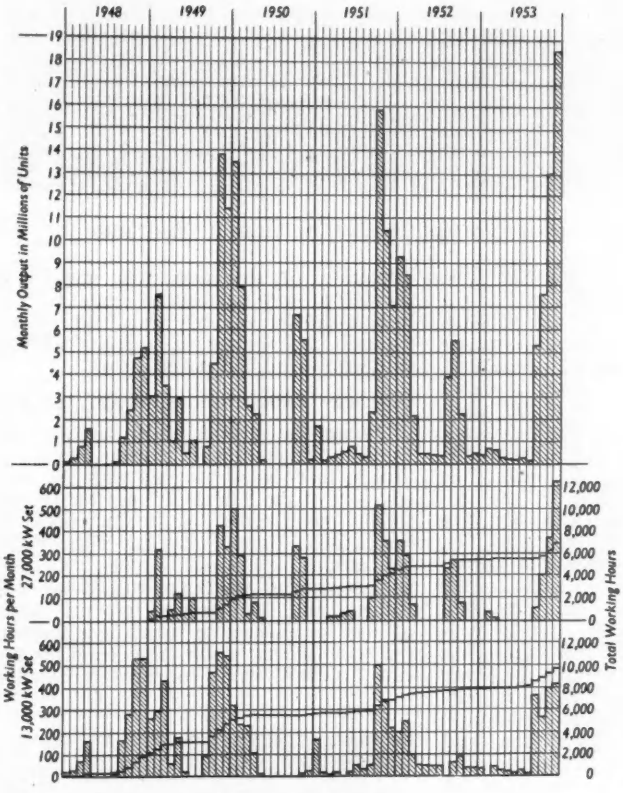
Aerial View of Beznau Gas Turbine Power Station



Day Load Diagrams, Beznau Power Station

described the present position of gas turbine development and the results obtained with existing plants, and outlined the problems of speed and load regulation in a propulsion plant. He stated that Brown Boveri gas turbines could now be equipped with regulating mechanism of the oil-operated type allowing the turbine to be run at constant speed, and be governed by the turbine temperature, or when running for long periods on a constant load, to choose the most suitable running speed.

On the propeller side, he notes, it was desirable to provide means for reversal and to be able with a standing propeller to run up to full speed in the ahead or astern directions of rotation. For these duties a propeller with adjustable blades offered a solution and electric transmission could be used. D.C. operation had some advantages for smaller ships and a.c. operation needed a pole-changing propeller motor. The fluid coupling also had advantages, he thought, in that low propeller speeds could be obtained with the slip of the coupling. In such a gas turbine marine installation the machinery foundations were similar to those for a steam turbine installation but the smoother running of the gas turbine permitted a somewhat lighter foundation. In the series of Brown Boveri reviews published last year, one was devoted entirely to "Gas Turbines," containing information on the running of existing gas turbine plants and some of the important research work carried out.



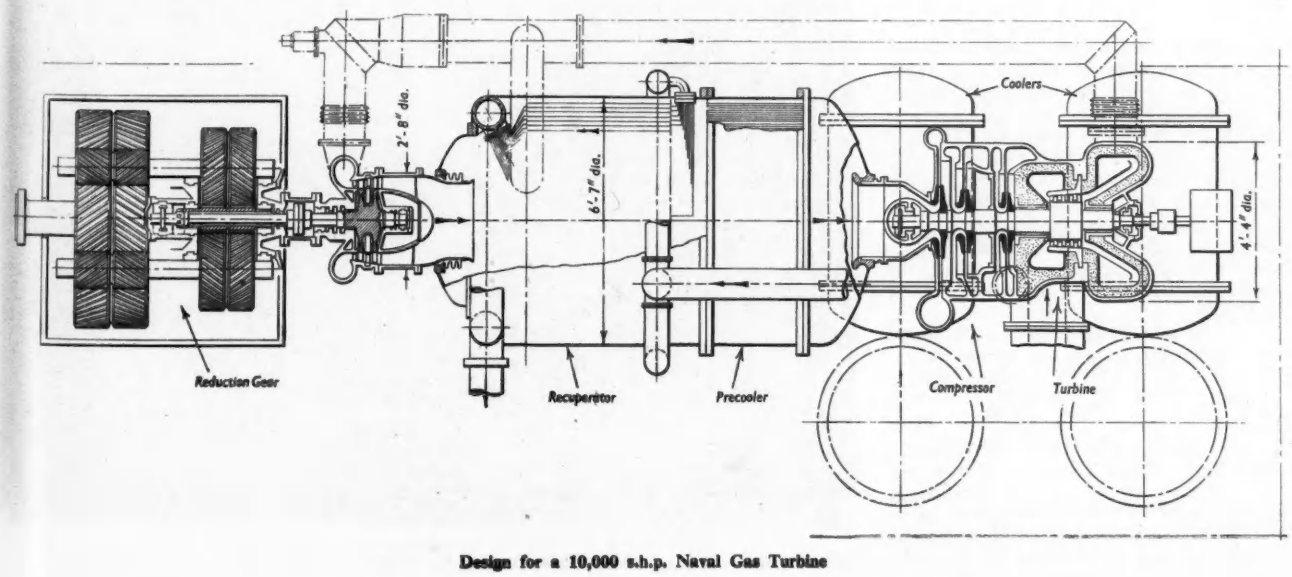
Operating Results of the Beznau Sets Since 1948

ESCHER WYSS, LTD., ZURICH

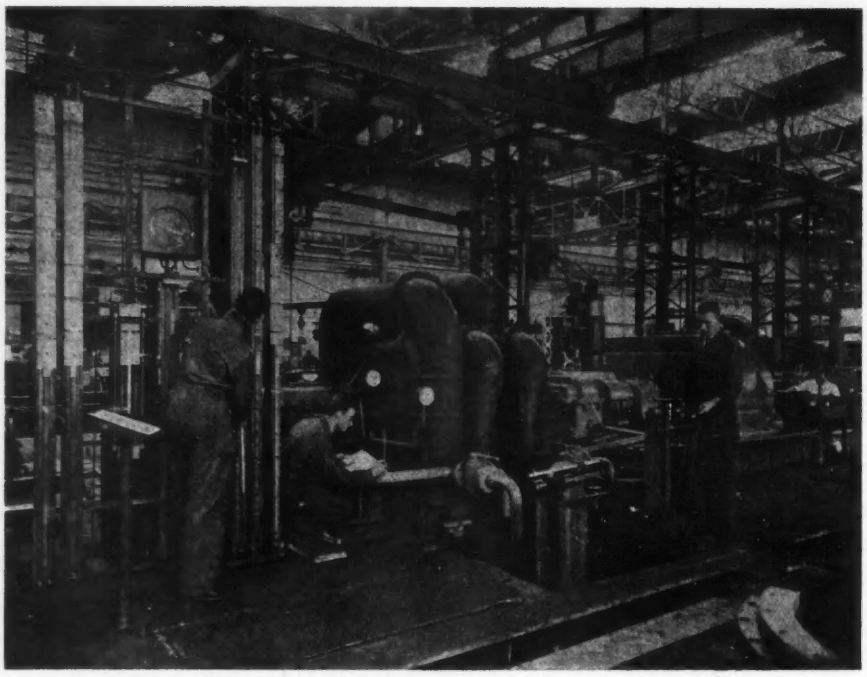
In the article published in our issue of February 13, 1953, we were able to give some details of the new Escher Wyss simplified design of combined gas turbine and compressor in one casing. We are now informed that during the year under review, designs of standard 2500kW, 6000kW and 12,000kW gas turbine units incorporating this new principle have been finished. The new design can quite well be applied to the three sizes and outputs above mentioned, and also to future larger machines, as the high pressures adopted give smaller dimensions for the rotor. In practice the maximum pressures used will be about 30 atmospheres. The new standard sets have been designed throughout for high efficiency and for long life. Research and development work on oil and gas-fired air heaters and coal-fired heaters have been completed, and new designs have been finished.

The manufacture of these sets for stationary operation is now, Escher Wyss, Ltd., informs us, well under way, and the first plant will come into operation in the course of 1954.

In addition to the work on stationary plant and waste heat recovery for different applications, during 1953 most of the firm's remaining activities were directed to the design of marine gas turbines for the propulsion of naval vessels and mercantile ships. Owing to the fact that the fuel consumption of a closed cycle gas turbine working on the Ackeret-Keller principle can be kept low over a wide range of loads, this kind of prime mover seemed to have special attractions for marine applications. A paper by Dr. C. Keller and Dr. W. Spillman,



Design for a 10,000 s.h.p. Naval Gas Turbine



Testing Three-Stage Uncooled Centrifugal Compressor for "Bone II" Gas Turbine

which was published in the November issue of *Schiff und Hafen*, and later, in *The Oil Engine and Gas Turbine*, dealt fully with the design and performance of closed cycle air turbine installations for marine propulsion.

In the accompanying diagram is shown the main machinery for a 10,000 s.h.p. naval gas turbine which has a high efficiency at partial loads. The plant is conveniently accessible and is comparatively small. The length between the couplings of the two turbines is approximately 23ft 8in, the diameter of the recuperator casing 6ft 7in, and the diameter of the combined turbine and compressor is 4ft 4in, while that of the power turbine is only 2ft 8in. The high-pressure compressor turbine set is constructed as a single shaft machine in the manner already referred to, while the power turbine for driving the propeller is a separate unit, designed for operation at variable speeds. The arrangement of the heat exchanger and the precooler between the two turbine units and the inter-coolers for the compressor may be noted. The saving of both space and weight with such an installation is quite favourable. In connection with the design of such plants, the firm has developed a new construction for heat exchanger tubes, in which an extended surface is obtained by using corrugated fins internally for high pressure air and externally for the low pressure air. The ribs are formed by passing metal strip through corrugated rollers and then winding it helically inside and outside the tube body. The strip is then secured to the tube by welding. This design, it is claimed, is highly efficient and is cheaper than the thin tubes of small bore which were used in the early closed cycle plants.

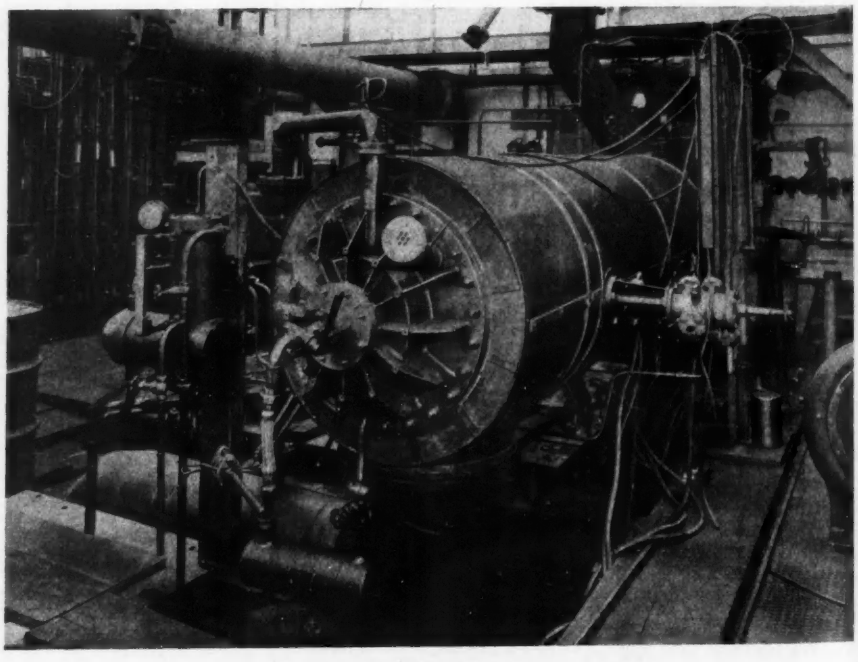
Last year we referred to the 12·5MW Escher Wyss closed cycle air turbine power plant installed in the St. Denis power station of Electricité de France, Paris. During 1953 this set was in operation for more than 2000 hours, at maximum temperatures of 675 deg. Cent. Besides carrying out continuous runs over longer periods, many regulation and shut-down tests with loads up to 10,000kW were successfully executed. Towards the end of the year a thorough inspection of the plant was made and showed a very satisfactory state of the turbine and the auxiliary plant and, as was expected, no fouling or deposits of any kind were found, the makers state.

Oerlikon Engineering Company, Zurich

During the period under review, the Oerlikon Engineering Company, Ltd., of Zurich, made good progress with the construction of the "Bône II" gas turbine set for the power station of the Compagnie de Electricité et Gaz, of Algiers. This 730kW gas turbine will work together with two auxiliary boilers which are utilised for providing steam, for injecting into the heavy oil fuel for preheating before it is fired in the main boilers, which raise steam for the two 25,000kW steam turbine sets installed in the station. The boiler fuel used is a heavy grade of "C" oil fuel with a viscosity of up to 500 deg. Engler, and 15,400 Redwood N.I. at a temperature 68 deg. Fah. The exhaust gases of the turbine unit will be at a temperature from 572 deg. to 752 deg. Fah. and contain up to 70 to 80 per cent of their original oxygen content, enabling them to be used in the boiler with a full recovery of the waste heat.

The speed of the compressor and gas turbine unit is 5250 r.p.m., the alternator and the exciter being run at 1500 r.p.m. through a Maag reduction gear. The alternator is a standard Oerlikon 915kVA machine.

In the accompanying illustration we are able to show the "Bône II" compressor unit under test at the Oerlikon works. For this purpose it is motor driven as shown, through its reduction gearing. The tests are now completed and the station will go into service during the present year. The illustration below shows the horizontal combustion chamber for the "Bône II" turbine. At the front of the chamber will be seen the oil fuel pipe at the centre, with an observation window above it to the right. From above comes the pipe for the supplementary air, while the horizontal main below brings the supply of air from the compressor. The regulating controls will be seen to the left and to the right the measuring instruments used on test are arranged. A feature of the Oerlikon centrifugal compressor to which we referred in a previous article, is the use of four diffusers per stage and this construction is clearly shown in our illustration. The same type of air compressor has been developed for industrial air supply and shortly before the end of 1953, a double flow centrifugal blower for a blast furnace came on the test bed and completed satisfactory trials. It has a designed volume flow of 43,500 cubic feet per minute, at a pressure ratio of 2, and the power input is 4660 s.h.p. at a maximum speed of 5580 r.p.m. The centrifugal compressor referred to has a high efficiency with a low surge factor, and its relative insensibility to dirt in the compressed air or gas give it advantages over other forms of air compressors and blowers.



Combustion Chamber for "Bone II" Gas Turbine

Research has been carried out during the year on the best form of blades for the entry of the air into the eye of the compressor or blower. In the illustration below we show an experimental blower with radial vanes undergoing test.

Other development work carried out by Oerlikon included that on problems of combustion with all kinds of oil fuels and the factors of stability and regulation were specially investigated.

During the year the firm's experimental gas turbine has been modified by discarding the speed reduction gear between the high pressure and the low pressure turbines. This experimental group is now a true free turbine installation. The high pressure turbine drives the alternator at a constant speed while the low pressure turbine drives the compressor at a variable speed which is a function of the load. The regulation and the control apparatus have been shown to be thoroughly reliable in their operation.

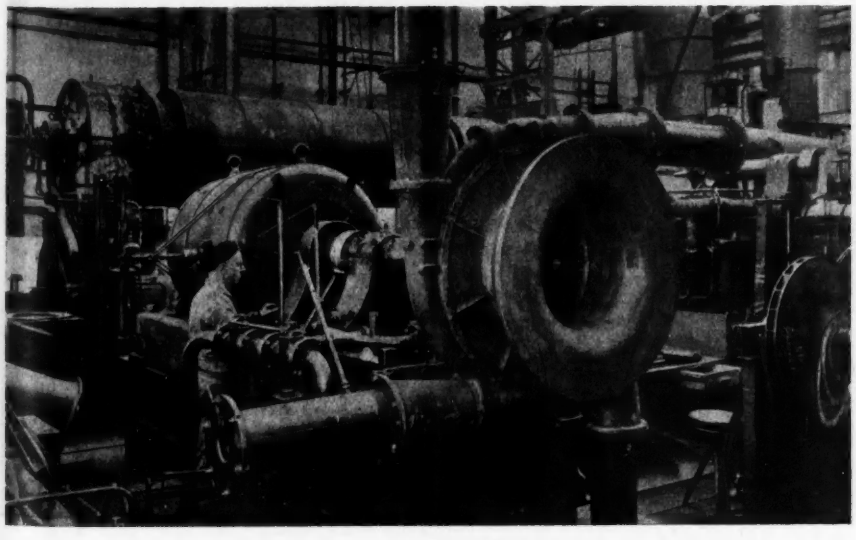
Sulzer Brothers, Ltd., Winterthur

In our article a year ago we reported that the Sulzer gas turbine plant at the Weinfelden power station of the North-East Switzerland grid system could only be run satisfactorily on distillate oil. This 20MW semi-closed, high pressure cycle plant can now use heavy fuels, as the problem of burning fuel oils with a high vanadium content is stated to have been solved. With this plant we may recall that high concentrations of combustion gases at high temperatures are attained, which in the past contributed to the difficulties met with by reason of deposits and corrosion. By adding certain aluminium silicates to the oil fuel it has proved possible to run the plant already for more than 1000 hours on heavy fuel oil without the blades showing any deposits or corrosion worth mention. The high efficiency of the plant, which surpasses 32 per cent at full load, makes the Weinfelden gas turbine installation probably more economical in fuel costs than any other machine of its kind.

During 1953 Sulzer Brothers received an order for two gas turbines generally similar to the Weinfelden unit, which will be installed in the steel works of Usines Métallurgiques du Hainaut, at Couillet, Belgium. Each of the two sets is designed for a power output of 7500kW and they will burn blast furnace gas. One of the units will be used to supply air to the furnace by means of a blower, which will be gas turbine-driven along with an alternator, while the second set will be used for generating electricity only. The two recuperators which work in parallel are accommodated under the turbine unit. The plant is of single shaft design and works with intermediate cooling, but without reheating. The blast furnace gases are brought up to the required pressure by a low pressure axial compressor, which operates in series with a high pressure radial compressor. These two machines are gear-driven from the main turbine shaft and are arranged at the side of it. An intermediate cooler between the two blast furnace gas compressors is also provided.

Both of these 7500kW gas turbine sets are designed for a maximum operating temperature of 1250 deg. Fah. and a maximum pressure of 7 atmospheres or 100 lb per square inch absolute.

The blast furnace blower of the unit is equipped to meet the normal operating conditions of the blast furnace. At times when more air is required it is tapped from the gas turbine cycle through a connection between the intermediate cooler and the delivery branch of the blast furnace blower. This arrangement provides for a convenient and economical regulation of the plant. Both of the gas turbine units above mentioned will, it is expected, attain a thermal efficiency of 24 per cent.



Experimental Compressor Showing Radial Vane Arrangement

Class "25" 4-8-4 Locomotives for South Africa

In 1951 *an order was placed with the North British Locomotive Company, Ltd., by the South African Railways and Harbours Administration for ten class "25NC" non-condensing locomotives, ninety class "25" condensing locomotives, and thirty condensing tenders. The* 4–8–4 *non-condensing and condensing locomotives are identical in most respects and weigh* 121 *tons in working order. At* 75 *per cent boiler pressure they have a tractive effort of* 45,360 *lb.*

THE South African Railways and Harbours Administration in 1951 placed orders for the supply of fifty class "25NC" non-condensing locomotives and ninety class "25" condensing locomotives. Under this order the North British Locomotive Company, Ltd., Springburn, Glasgow, received a contract for ten of the non-condensing locomotives, all of the condensing locomotives and thirty of the condensing tenders. The remaining forty non-condensing engines and sixty condensing tenders were ordered from Henschel and Sohn, G.m.b.H.

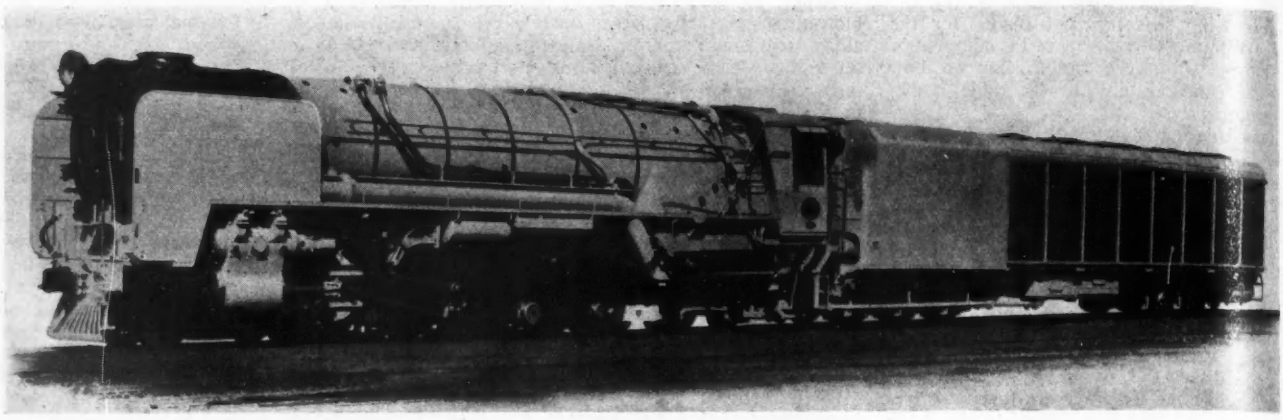
The locomotives are being built to the specification and requirements of the mechanical department of the South African Railways and under the supervision of the Advisory Engineer, High Commissioner's Office, London. The design work in connection with this contract has involved close collaboration between the British and German locomotive firms, and a satisfactory working arrangement was arrived at which permitted the detail design of the condensing and non-condensing locomotives to proceed at the same time. Both North British Locomotive Company and Henschel and Sohn have completed delivery of the non-condensing locomotives ordered. These locomotives are identical to the condensing locomotives, as described below, with the exception of minor modifications required to accommodate the condensing equipment. A large number of the condensing locomotives have already been delivered. The leading particulars of the engines are given in the accompanying table, and the general arrangement can be seen in the drawing we reproduce on page 277.

Leading Particulars of 4-8-4 *Class "25" Locomotives*

Gauge	3ft 6in
Cylinders (two), diameter and stroke	24in × 28in
Coupled wheels, diameter	5ft
Bogie wheels, diameter	2ft 6in
Trailing truck wheels, diameter	2ft 6in
Rigid wheel base	15ft 9in
Total wheel base	38ft
Boiler pressure	225 lb per sq in
Grate area	70 sq ft
Heating surfaces :	
Small tubes	1,965 sq ft
Large tubes	1,094 sq ft
Firebox	294 sq ft
Circulators	37 sq ft
Total evaporative	3,390 sq ft
Superheater	630 sq ft
Total	4,020 sq ft
Weight in working order	121 tons
Adhesive weight	75 tons
Maximum permissible axle load	18 tons 15 cwt
Tractive effort at 75 per cent boiler pressure	45,360 lb
Tender :	
Wheels, diameter	2ft 10in
Bogie wheel base	10ft
Total wheel base	45ft 10in
Coal capacity	19 tons
Fresh water capacity	4,400 gallons
Condensate capacity	600 gallons
Weight in working order	109½ tons
Weight of engine and tender in working order	230½ tons
Total wheel base of engine and tender	95ft
Total length over couplers	108ft

The boiler barrel, which is 22ft 8in long, consists of three rings, the middle ring being tapered. The barrel diameters are 6ft 5¾in at the front and 7ft at the rear, and it accommodates 158 tubes 2¼in outside diameter and forty superheater flue tubes 5½in outside diameter. The distance between the tube plates has been reduced from 22ft 6in, as in the "15F" class locomotives, to 19ft by the use of a combustion chamber. While this results in a slight decrease in the total evaporative heating surface, there is a 40 per cent increase in the relatively more valuable firebox heating surface and a better ratio of firebox volume to grate area.

One of the photographs we reproduce shows a boiler and firebox at the maker's works, and it is pointed out that there are several innovations in the boiler design compared with previous S.A.R. practice. The round top outer firebox is welded throughout, the wrapper plate being in three pieces with the top plate thicker than



Class "25" 4-8-4 Condensing Locomotive for South Africa

the sides. The throat plate and firebox back plate are welded to the wrapper plate, while the connection to the barrel is made by a double riveted joint with a row of partly rigid and partly flexible stays interposed between the rivets. In one of the illustrations an inner firebox can be seen in course of fabrication on its welding fixture. Another new point in the construction of these fireboxes is the use of circulating tubes in the place of the more conventional arch tubes. These circulating tubes are now being manufactured in this country by the North British Locomotive Company and take the form of an inverted tee connecting the firebox roof to the side legs. Four rows are arranged in the firebox and give added circulation as well as providing adequate support for the brick arch.

The inner and outer fireboxes are welded to a foundation ring of U-section pressed steel plate, of the kind first introduced in this country on the Southern Railway, and this permits the provision of a water leg 6in in width.

Extensive use is made of flexible stays. The first three rows of roof stays, the areas in the vicinity of the circulating tubes, the major portion of the combustion chamber and large sections of the firebox sides and back are fitted with flexible stays. Firebox cross stays have been dispensed with, an additional row of radial stays being fitted on either side.

Gusset stays provided at the firebox back and smokebox tube plates are arranged vertically to overcome cracking experienced with horizontally disposed gussets on previous locomotives. The firebox is 10ft long by 7ft wide inside, and in view of this size a fabricated cross stay is secured to the underside of the foundation ring midway along its length. This cross stay also provides a support for the firebar bearers.

The firegrate consists of four groups of rocking bars, actuated by steam power, and two dumping sections. The air opening provided is 28 per cent of the grate area. The ashpan, which is carried on the main frames, has a bottom sliding door. Its drench is taken from one of the boiler blow-down cocks, with an alternative connection on the non-condensing engines only to one injector delivery pipe. The discharge from various small drains is collected in a main collector pipe and also discharges into the ashpan.

The smokebox of the condensing locomotive is similar to that fitted to the non-condensing type, with the front extended to accommodate a vertical centrifugal blower which is driven through bevel gears by an exhaust steam turbine mounted under the front of the smokebox. The smokebox front plate, in addition to being bolted to the angle ring, is also hinged to the wrapper plate, thus facilitating ready access to the blower equipment, superheater header and tubes.

The "Melesco" multi-valve superheater, which is common to both designs, has forty elements. In an endeavour to eliminate trouble experienced with cracked headers the header is carried from the smokebox tube plate flange instead of the wrapper as is the usual practice. The boiler and cylinders are lagged with "Cape" asbestos mattresses, the mattresses being manufactured and fitted in South Africa.

As the temperature of the feed water on the condensing engines is too high for the use of ordinary injectors, the boiler is fed by two turbo-pumps situated under the cab. Each pump has a capacity of approximately 88 gallons per minute and can supply boiling water at a low head. Four 2in diameter Ross "Pop" safety valves are fitted, the discharge from one valve, which is set slightly below the pressure load of the others, being collected in the main exhaust pipe. Two "Hopkinson" blow-down valves are arranged at the bottom of the firebox wrapper.

The auxiliaries draw their steam from two steam turrets which are fed with saturated steam by external piping from two shut-down valves, all located on top of the boiler barrel. Considerable thought was given to the arrangement of mountings on the firebox back and a full-size "mock-up" of the cab was built before the positions were finally settled.

The main frames are one-piece steel castings, with the cylinders, including hind cylinder covers, and front buffer beam cast integral. The castings were supplied by General Steel Castings Corporation of America and the approximate weight of a finished casting is 18 tons. The frame was designed in close collaboration with the builders to specified weight limits and for weight distribution purposes the centre of gravity was held within a small dimensional range.

The cannon design coupled axleboxes have British Timken roller bearings. "Franklin" compensators and snubbers having compensator wedges of cast steel faced with bronze are fitted to the horn gaps. The overhung coupled bearing springs which are fitted to the locomotive are fully compensated, forming a group with the trailing bogie. The frames for both the leading and trailing four-wheel bogies are one-piece steel castings, also manufactured by the General Steel Castings Corporation. Timken roller bearing axleboxes are fitted to the bogies, those for the leading bogie being of the cannon type.

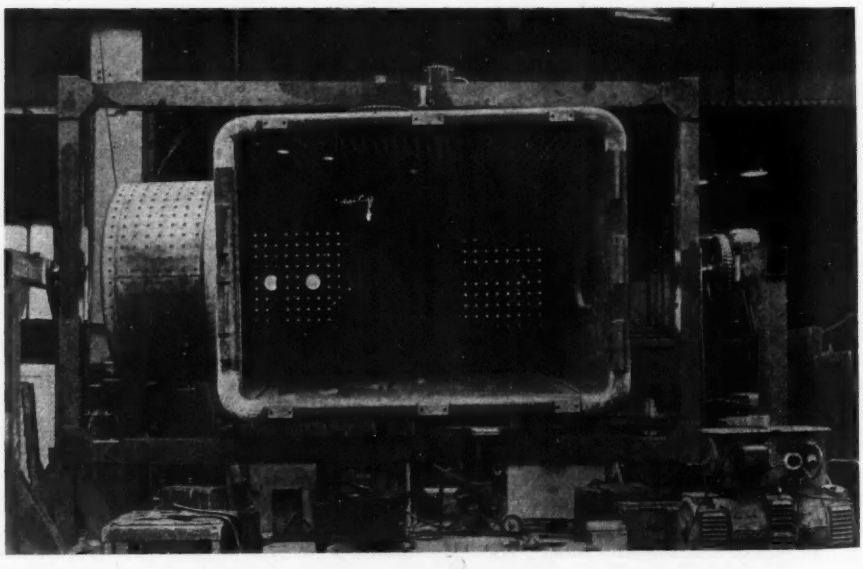
The side control devices are of the constant resistance design, supplied with the frames, and the degree of side play permits the locomotive to negotiate curves of 275ft radius with $\frac{1}{4}$in gauge widening and $4\frac{1}{2}$in superelevation.

The wheels, axles and axleboxes of the leading bogie are designed to be interchangeable with those of the S.A.R.'s existing "15F" class locomotives, while the wheels and axles of the trailing bogie are interchangeable with those of the "24" class bogie.

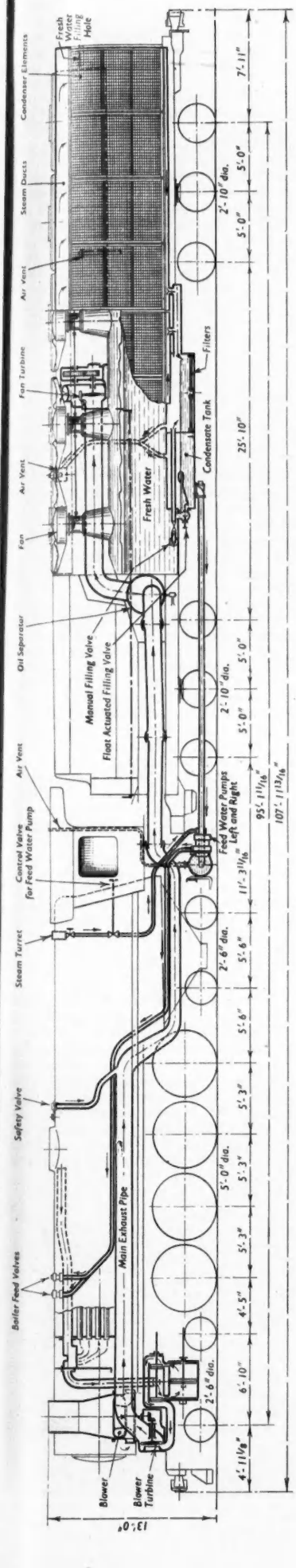
The cylinders are fitted with renewable cast iron liners in the barrels and steam chests. In addition to S.A.R. standard by-pass, drain and drifting valves, a diaphragm cylinder pressure release safety device is fitted. A steam chest pressure gauge with anti-pulsation device is also included as part of the equipment.

The pistons and piston valve heads are drop forgings of 40–45 tons steel and are fitted with "Koppers" segmental piston and valve rings. The ring grooves of both the pistons and valve heads are flame hardened as are the wearing surfaces of the slide bars and reversing links. "Paxton Mitchell" metallic packing is fitted to the piston-rods.

The split crossheads are of the "Alligator" design with cast iron slippers, and they are



Inner Firebox on Welding Fixture



General Arrangement of Class "25" Condensing Locomotive

fixed to the piston-rod by a triple-coned ring fastening. A hollow bored gudgeon pin is carried in taper roller bearings, and oil lubrication to those bearings is provided through the hollow pin.

Walschaerts valve gear operates the 12in diameter piston valves which have a maximum travel of 7¾in. The reversing gear is of the "Hadfield" power-operated type. "Skefko" roller bearings are fitted to the eccentric crank and the remainder of the motion pins are of double taper construction. The motion is grease lubricated throughout, excepting the dieblock, which is supplied with oil from the mechanical lubricator.

Taper roller bearings are fitted to all crank pins, the design of the coupling and connecting-rods having been developed in close collaboration between British Timken and the locomotive builders. Both the connecting and coupling rods are of fluted section, the connecting-rods being forged from EN 13 manganese-nickel-molybdenum steel. The flanks of the rod eyes are cold rolled, as are also the coupled axles, crank pins and wheel seats.

A departure from the S.A.R.'s previous practice has been the adoption of mechanical lubrication. A sixteen-feed lubricator is driven off the reversing link trunnion, a roller bearing being fitted at the driving end, while a rubber connection is employed at the driving arm of the lubricator. The non-condensing engines are fitted with lubricators made by C. C. Wakefield and Co., Ltd., and the condensing engines with components made by Davies and Metcalfe, Ltd.

Vacuum brake equipment is fitted on engine and tender. The locomotive brake blocks, fitted at the front of the coupled wheels, are operated by two 24in diameter cylinders, and the tender clasp brakes are operated by four 21in diameter cylinders. The brake riggings on the tender bogies are independent of each other, and a hand brake operating on the front tender bogie only is also provided. Delaying valves are interposed in the locomotive and tender pipelines to delay the application of the locomotive and tender brakes until a predetermined degree of braking has been established throughout the train. The separate driver's brake valve has an isolating valve attached which permits the engine and tender brakes to be held on while the train brakes are being released or vacuum built up. Sanding is provided to the front of the leading coupled wheels only, the gear being hand operated from the cab.

Automatic "Alliance" couplers are provided at front of engine and rear of tender, the tender coupler being fitted with "Spencer Moulton" rubber drawgear.

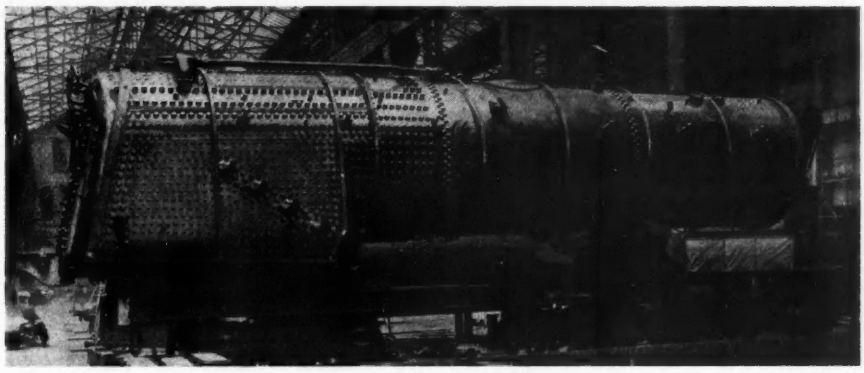
The engine cab is of all-welded construction and, as already mentioned, the layout was the subject of close study to provide good operating facilities for the crew, who are provided with adjustable spring-mounted bucket seats.

The tender for the condensing locomotive has, like that for the non-condensing engine, a one-piece cast steel water bottom frame supplied by General Steel Castings Corporation. The condensing tender is some 16ft longer than the other tender and in it the sides of the structure behind the bunker are formed by the condensing elements. The centre is occupied by the fresh water tank on top of which are mounted five fans which draw in the air to condense the exhaust steam. The cast steel tender bogie frames are fitted with Timken roller bearing axleboxes. They have double helical spring suspension fitted with "Symington Gould" snubbers.

The fifty non-condensing and sixty of the condensing locomotives are being fitted with standard "H.T.1" mechanical stokers designed to operate at a maximum delivery rate of 12,000 lb of coal per hour. A sliding firedoor is fitted to these engines. The remaining thirty locomotives are being fitted with "Berkley" stokers and butterfly firedoors. The space allocated for the installation of the stoker, however, is such that these units can be interchanged if necessary.

Electric lighting equipment and electrical speedometers supplied by J. Stone and Co., Ltd., are fitted to the locomotives.

The condensing equipment for the locomotives has been designed and is being supplied by Henschel and Sohn. This firm in 1949 supplied a condensing tender and the equipment for the conversion of an S.A.R. 2–10–2 class "20" locomotive. It was after tests with this locomotive that the order was placed for the present engines. In this condensing system the exhaust steam from the cylinders is passed into a turbine driving a fan blower in the smokebox which replaces the normal blast pipe draft. From the blower turbine the exhaust steam passes along the side of the engine, then through an oil separator to another turbine in the tender. This turbine drives the air intake fans through bevel gears on a line shaft. Finally, the steam passes to the condensing elements mounted on both sides of the tender. The condensate is collected in a tank fitted underneath the tender frame and is fed back into the boiler.



Boiler and Firebox

Tugela Basin Development, Natal

THE development of the Tugela Basin, Natal, with its vast coalfields, iron and mineral deposits nearby, has now been taken a step further. This basin has been described as the key to the future industrial development of South Africa. The Tugela, Mooi and Buffalo rivers flow into the Basin and drain an area of about 3,000,000 acres of the heaviest rainfall belt in the country. It has been estimated that if the full flow of the Basin were used, it could support a population of 45,000,000 and even if one-tenth of the flow were utilised, 4,000,000 people could easily be supported. The Tugela Basin has fifteen times the annual flow of water in the Vaal River which supplies 2,000,000 people. The Town and Regional Planning Commission, Natal, is responsible for the survey of the potential uses of the Tugela Basin. The Commission has now advertised two fellowships, one connected with railway rating and the other with plant ecology. The railway fellowship will be for research into the effect of railway rating on the location of industry in inland Natal, with particular reference to the Tugela Basin. Both fellowships are under the supervision of the University of Natal.

Pipe Flanges Research

THE INSTITUTION OF MECHANICAL ENGINEERS

AT a meeting of the Institution of Mechanical Engineers on Friday, February 12th, the third report of the Pipe Flanges Research Committee was presented and discussed. The report was prepared for the Committee by A. E. Johnson, of the D.S.I.R., Mechanics and Materials Division, East Kilbride. The report deals with work carried out at the National Physical Laboratory and the Mechanical Engineering Research Laboratory since the issue of the second report in 1939.

The third report of the Pipe Flanges Research Committee is concerned, with the exception of elastic resistance strain gauge measurement of stresses of two standard flange rings, with the results of a programme of investigation, projected by the committee in being when the second report was made, into the elastic and plastic (creep relaxation) behaviour of flanges, drilled and undrilled, by means of model flanges, and of certain bolt materials. Execution and completion of the programme and attention to its results, was interrupted and delayed by the 1939–45 war. Subsequently examination of the creep relaxation data showed that the phenomenon, and the interpretation of the results involved difficulties unknown at the time the tests were made, and the need for further investigation became evident. The results, however, have an important bearing upon the behaviour of flanged joints and make a contribution to the subject providing a base for further advances. An addendum to the report by R. W. Bailey refers to matters which arise in connection with utilisation of its results for engineering needs. We print below extracts from the remarks of some of those who took part in the discussion.

Discussion

Mr. W. W. Campbell, in opening the discussion, said that the object of the whole research might be one of two things. It had been in 1931 that the British Standards Institution had put out its Table T, greatly daring and very tentatively. It was following on this that the whole research had been initiated. The terms of reference had been research into the strength of pipe flanges and bolt connections for use at high temperatures and high pressures and the conditions affecting tightness, and the programme of tests had included a number of investigations into certain fundamental matters, such as the effect of pressure on drawing tightness for various bolts and materials, and full-scale tests on certain flanges, in particular the Table T 8in flange carbon steel. The first and second reports had produced a great deal of useful data of a fundamental nature and some results on model tests, the model tests having been conducted to determine leakage on the accepted standard at that time of 150 grammes per hour, or approximately 1 gallon per day.

Eighteen years later there was this third report, which showed an enormous amount of very useful work, especially on elastic behaviour and creep relaxation on flange rings and, to some extent, on bolts, and further tests on Table T 8in carbon steel flanges, presumably with the same criterion of leakage. They seemed to be accumulating a good deal of data largely centring around Table T and the particular flange in it and under steady state conditions. He gathered that it took quite a time for these flanges to get up to the temperature of their tests. What he thought it was worth asking now—having had this third report presented—was whether they could now use this data either to confirm or to modify the applicability of Table T, which was still tentative, after a lapse of approximately a quarter of a century, or, alternatively, to obtain the applicability of the relaxation with alloy steel, which was of even greater importance. There were in the third report certain life curves. Could they be used ? Apart from the extrapolation did those life curves apply, for example, to other sizes of joints in the same table ? What about thermal effect due to changes in temperature (which occurred in service even if they did not occur in the tests), two-shift operation involving daily changes of temperature in both directions, and drainage effects involving water quenching ?

In the discussion on the second report, or perhaps the first report, they had been promised that certain work was to be done on temperature effect on flanges. What about bending moments on the pipe, which would certainly be there in practice, although not in the tests ? Here there was some controversy. There was a powerful school of thought which regarded bending moment as non-effective. Was that correct ? What about the ensuring of tightness by a seal weld instead of the packings which had been in customary use in 1931 and which had been the subject of the original research to a certain extent ? Could they, in fact, use these life curves, and, if not, what was to happen now ? Table T was still tentative, approaching its silver jubilee, waiting presumably for this blessing from the research committee which it had been led to believe it would get. As far as that local issue was concerned, the question which must be in the minds of many people was whether consideration of Table T ought to await any further work that might be done in this research, and, if so, what kind of work was envisaged ?

There was, of course, another side issue there, namely, that the suitability of the data might be a little questionable if high pressure and high temperature was taken to mean temperatures below 875 deg. Fah. and pressures about 1000 lb, because this was not a very common combination of steam conditions. If something higher than 875 deg. Fah. was meant, then an alloy steel was required, and it might be that some of these results were not immediately applicable to the lower pressures. The second possible object of the research, and one where it might perhaps be of greatest value, was in enabling generalisations to be made on flange behaviour in order to permit flange design possibly to be radically reorganised and radical changes made with a knowledge of what exactly each individual change would produce. That could not be done without a knowledge of such fundamental data as the research committee and its workers had been preparing. For example, should the flange not be radically different from Table T ? Should it, for example, be much more flexible in order to accommodate temperature stresses without leakage ? Should it be tackled in a completely different way by adopting special means to bring the pitch circle diameter very much more close to the pipe diameter in order to reduce the thickness and, therefore, the temperature differences on starting ? Should there be some quite special form of joints ? In considering that kind of problem, one had to consider whether the data which had been produced in the research was, in fact, capable of generalisation. He was thinking, for example, of the formulæ which had been used to fit certain experimental curves. Were they going to be applicable with all kinds of different shapes of joints, or did they happen to fit because the flange shape happened to be something like what it was ? Of course, if high pressure and high temperature still meant 3000 lb per square inch and 1000 deg. Fah., as the committee had sworn that it did when they started the investigation, then clearly Table T might not be at all applicable, and there was the even more pressing point that the longer they went on and the higher the pressure and the temperature became, the less popular the flange became. One would not really expect it to happen, but it would certainly be rather odd if it did occur that they managed to obtain perfection in the design of flanges for bolted connections at approximately the same time as the last flange passed out of use in the design of high-pressure pipe systems !

Mr. Jenkin said that it was now nearly a quarter of a century since B.S. Table T had been first produced, and B.S. Table S had been produced a little while before that. Both those tables had been open to some criticism, but he thought that generally they had proved to be quite satisfactory for the conditions for which they had been first designed. Another table, B.S. Table R, had definitely proved to be weak and had always given trouble ; but Tables S and T had been suitable—Table S for 900 lb and 800 deg. Fah., and Table T for 1400 lb and 800 deg. Fah. The trouble had been as to the conditions in which these tables could be used for higher temperatures and lower pressures. In particular, there had been anxiety to know whether they would be suitable for the 600 lb and 850 deg. Fah. standard turbines and the 900 lb and 900 deg. Fah. turbines. The Table S flanges had been used for the 600 lb and 850 deg. Fah. turbine or the 650 lb and 865 deg. Fah. boiler conditions, and they had proved satisfactory. One was not so sure about the Table T flange, which was now used for 925 lb and 915 deg. Fah. or 925 deg. Fah., but as those flanges had generally been made in alloyed steel instead of the carbon steel for which the table had been originally designed, they had not given a great deal of trouble. It was this correlation of pressures and temperatures which he had hoped would be solved by the third report of the committee, and there were some results which might be picked out for comparison. He would like to know whether the committee had been able to correlate them in any form which would help the user in being able to pick out the right table for the standard conditions which were now employed for turbine work.

Mr. Bugden thought it could be fairly stated that flanges were on their way out, particularly loose flanges, i.e. flanges connected with what were called seal-welded joints, which he had always regarded as being somewhat dangerous. In the case of bolt relaxation with the gasket joint, warning was given by the leaking of the joint ; but with the seal-welded joint that deficiency was covered up and a dangerous state might exist. Therefore, in his view, both gasket joints and seal-welded joints would in time be replaced. That process was already going on in that in modern plants it was now customary to weld up the whole main from boiler to turbine. They must also face the fact that modern service conditions postulated the use of materials not covered by the report, and therefore one wondered how far some of the tests were representative of performance in service. With due deference to Mr. Jenkin, he felt that Table R was suspect ; indeed, he thought that in sizes up to and including 5in the table was definitely bad. Table S was also subject to adverse criticism, and Table T, he thought, had not been used to any great extent as it existed in British Standard Table T. The report itself, of course, made no direct recommendation for modification or otherwise of the British Standard flanges, and, in fact, such recommendations appeared to be impossible at this stage of the research. They needed the results of research on flanges attached to pipes and attached in various ways and with the pipes subjected to bending moments, such a condition being representative of service conditions of pipework containing hot fluids. The method of securing the flange to the pipe might be significant. It was to be hoped that all the research work would enable them to review and revise as requisite the British Standard flange tables, the completion of this task being long overdue.

Hydro-Electric Progress in Canada in 1953.—The Water Resources Division of the Canadian Ministry of Resources and Development has issued a report which states that during 1953 Canadian construction activities continued at a high level on new water-power plants and extensions to existing plants ; those completed in 1953 totalled 638,012 h.p., bringing the total installed capacity of all hydraulic plants in Canada to 14,921,459 h.p. Other new water-power projects and enlargements of plants are under active construction or are definitely planned. Construction of thermal-electric stations also proceeded vigorously. These new developments are well distributed across Canada although the Province of Quebec continues to maintain its lead in water-power installation. Continued rapid expansion of hydro-electric development will obtain in the next few years, and it is anticipated that the record amount of 1,500,000 h.p. will be completed in 1954 ; a similar amount is under construction for operation in later years. During 1953 there was great activity in the installation of transmission lines and distribution facilities, to meet an increase in power demand of about 7 per cent. Good progress was made in rural electrification.

P. and O. Liner "Arcadia"

No. I

The liner "Arcadia" has recently joined the fleet of the Peninsular and Oriental Steam Navigation Company and sails on her maiden voyage in that company's service to Australia on February 22nd. A total of 679 first and 735 tourist-class passengers are carried and the ship, which has a length overall of 720ft and a gross tonnage of 29,734, is propelled at a service speed of 22·5 knots. Two sets of double reduction geared turbines develop a total propulsive power of 34,000 s.h.p. and take steam at 500 lb per square inch pressure and 800 deg. Fah.

ON February 22nd the passenger liner "Arcadia" sails from Tilbury, under the command of Captain G. C. Forrest, on her maiden voyage to Australia and is expected to arrive at Sydney on March 27th after calling *en route* at Port Said, Aden, Bombay, Colombo, Fremantle and Melbourne. The liner, which has been built and engined by John Brown and Co. (Clydebank), Ltd., was launched on May 14, 1953, and named by Mrs. D. F. Anderson, the wife of the deputy chairman of the owners, the Peninsular and Oriental Steam Navigation Company. This is the second vessel to bear the name "Arcadia," the first being a ship of 6188 tons gross and one of the "Jubilee" class of 1887/8, built by Harland and Wolff, Ltd., at Belfast, and powered by a triple expansion engine of 7500 h.p. One illustration shows the first "Arcadia" which had a speed of 16 knots and accommodation for 250 first and 150 second-class passengers.

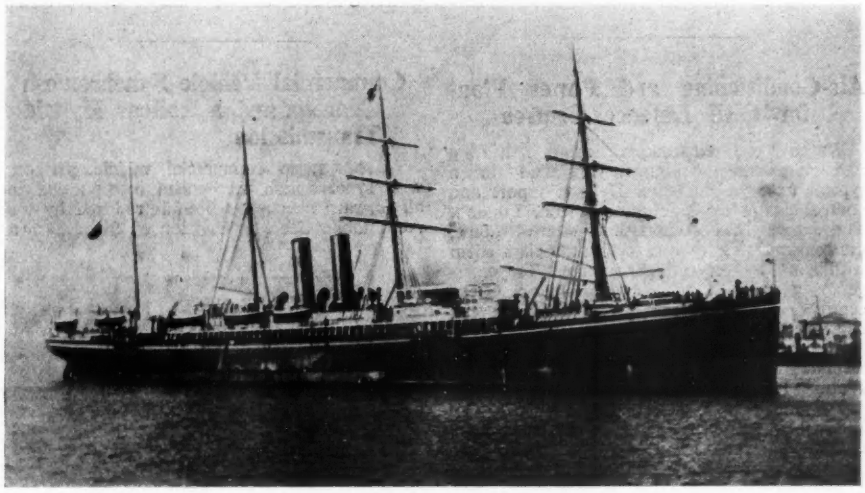
When the new ship is joined later in the year by her sister ship, "Iberia," it is intended that the two liners, in association with the "Himalaya," which has been in service since the latter part of 1949, and in conjunction with three Orient liners, will maintain a fortnightly service to Australia. However, following her maiden voyage, the "Arcadia" will be engaged in a number of holiday cruises from May until October. At the invitation of the owners we were able to take part in the pre-maiden voyage cruise from the Clyde to Tilbury and it was of interest to learn that Captain G. S. Stable, an ex-commodore of the company, and Mr. Sydney Rawson, both of whom served in the earlier ship of the same name, were on board.

From the accompanying illustration it will be seen that the ship with her white painted hull, curved and raked stem, long forecastle and radiused superstructure front and two raked masts, presents an impressive profile dominated by the large streamlined buff funnel. This has been specially designed to eliminate the nuisance of smoke and smuts falling on the promenade and sports decks, and the shape adopted incorporates the results of smoke tests carried out in the wind tunnel of Thermotank, Ltd. The pleasing external appearance of the liner does not infer that she is a luxury ship, for the aim of the designers has been to produce an economically operated and efficient ship. The "Arcadia," which has a family likeness to the "Himalaya," in that some of her main dimensions are similar, is the fourth ship built at Clydebank for the owners, and is powered by two sets of double reduction geared turbines of sufficient power to give a service speed of 22·5 knots.

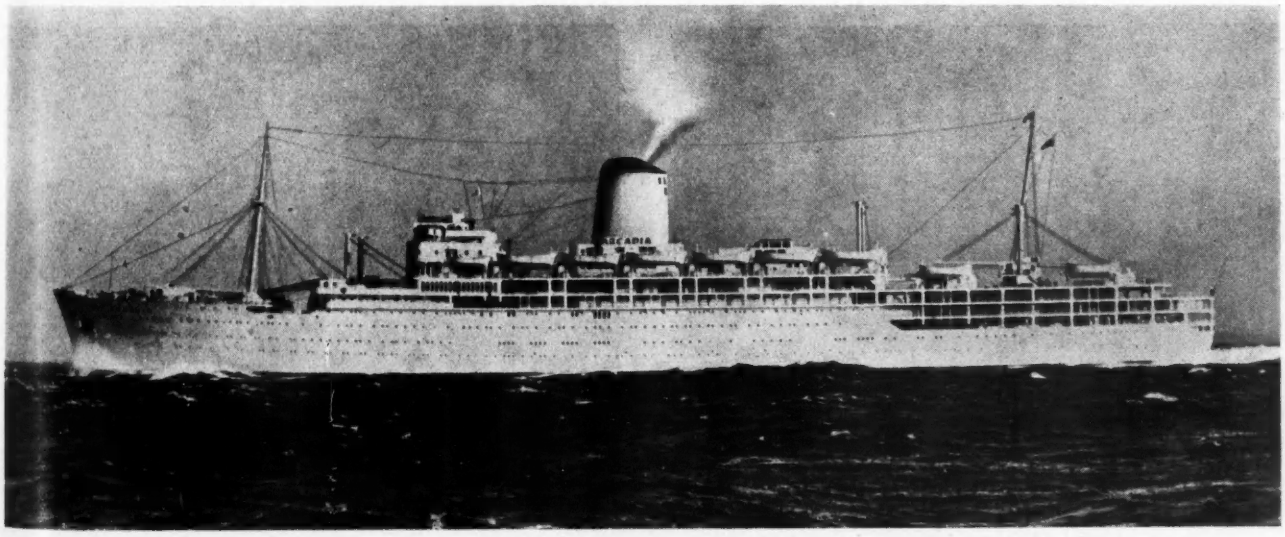
The ship has been built under the survey of Lloyd's Register of Shipping and to the requirements of the Ministry of Transport, the lines of the hull being determined upon the results of model experiments carried out in the shipbuilder's experimental tank. A two compartment standard of sub-division is attained by ten transverse water-tight bulkheads above the double bottom which is sub-divided into twenty-four water-tight compartments, carrying fresh water, reserve feed water, oil fuel or water ballast. Additional oil fuel is carried in wing bunkers extending over the length of the refri-

Dimensions and Particulars of Liner "Arcadia"

Length overall	720ft
Length between perpendiculars	668ft
Breadth moulded	90ft 6in
Depth moulded to "C" deck	49ft 9in
Speed, knots	22·5
Gross tonnage	29,734
General cargo	166,979 cu ft
Insulated cargo	153,813 cu ft
Accommodation	
First-class passengers	679
Tourist-class passengers	735
Crew	711
Propelling Machinery	
Twin screw, double reduction Parsons geared turbines :	
Normal power (at 130 propeller revolutions per minute)	34,000 s.h.p.
Maximum power (at 140 propeller revolutions per minute)	42,500 s.h.p.
Astern power (percentage of normal ahead power)	65
Steam supply	500 lb per sq in 800 deg. Fah.
Three two-furnace Foster-Wheeler controlled superheat design boilers :	
Steam pressure	530 lb per sq in
Superheat range	850 deg. down to 600 deg. Fah.
Electrical Machinery	
Three British Thomson-Houston turbo-generators :	
Rating	1200kW, 225V d.c.
Overload (two hours)	1500kW
Two W. H. Allen diesel-driven generators (emergency) :	
Rating	100kW, 225V d.c.



Steamship "Arcadia" of 1887



P. and O. Liner "Arcadia"

gerating machinery compartment and the boiler-room, at the forward end of which are cross bunkers. Deep tanks built in the wings abreast the tunnels provide extra storage capacity for fresh water.

There is a total of nine decks, eight of which are wholly or in part allocated to the accommodation of the passengers and crew, and the arrangements are in accord with present day ideas of style and comfort, while adequate space is allocated to recreation purposes. Greater passenger comfort is also provided for by the installation of Denny-Brown hydrofin automatic stabilisers which considerably reduce the amplitude of roll in rough weather.

Provision is made for the carriage of general cargo in two holds and three 'tween decks and insulated cargo in three holds and three 'tween decks, situated forward and aft of the machinery spaces. Construction follows normal transverse framing practice in association with a cellular double bottom, which incorporates a duct keel extending from the boiler-room to No. 1 hold, and four rows of pillars.

(To be continued)

Air-Conditioning and Power Plant for Civil Defence Centres

WE have received some particulars of heating and ventilating equipment installed in a typical underground Civil Defence report and control centre at Paddington Green, London. These underground centres have control rooms, kitchens and sleeping quarters, and a plant room with stand-by generating equipment for emergency purposes. At the Paddington Green centre only two concrete ventilation shafts can be seen above ground level, and a heating, ventilating and emergency generator plant has been installed by G. N. Haden and Sons, Ltd., 19, Woburn Place, London, W.C.1.

Two fans have been provided, each of which is designed to deliver 1000 cubic feet per minute. One of these fans is used for normal ventilation purposes, and draws fresh air from a 30ft high intake shaft through a cotton wool filter. The other fan is installed for use in the event of a gas attack, and is capable of handling the required volume of air against the greater resistance of gas filters. Each fan is fitted with duplicate motors and starters.

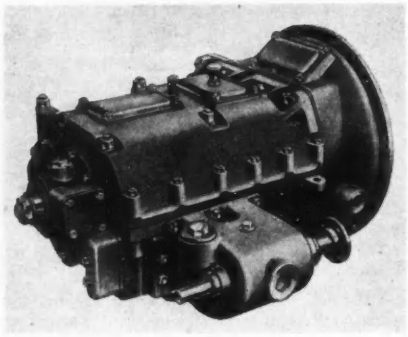
The air is delivered through a 27kW electric air heater arranged in three banks each balanced over three phases. The output of the heater is controlled by three room thermostats set to bring on the heater in stages, and an overriding thermostat in the duct is arranged to switch on one heater stage if the incoming air is below room temperature. Safety interlocks are provided to prevent the heater operating unless one of the fans is running. The warm filtered air is distributed by galvanised sheet steel trunking and is discharged in the rooms through louvred grilles. A plenum of 0·2 w.g. is maintained throughout the building by allowing the air to escape through loaded evacuation valves. The installation is designed to maintain a temperature of 65 deg. Fah. when the outside temperature is 30 deg. Fah.

In the event of the mains power supply being cut off a diesel engine generator set, shown in the accompanying illustration, is brought into service. The generator set, made by R. A. Lister and Co., Ltd., Dursley, Glos, consists of a 16 h.p., 1500 r.p.m. diesel engine directly coupled to a generator with an output of 8·5kW at 400V, three-phase 50 cycles.

The diesel engine cooling system is somewhat unusual. Instead of the conventional radiator a special radiator has been fitted into a gastight duct with an aerofoil fan drawing air from the intake shaft of the building. The exhaust from the engine is led into the cooling air discharge shaft. The generating set is supported on special mountings to prevent the transmission of vibration and noise, and the fan bases are isolated from the floor by cork blocks.

Commercial Vehicle Synchromesh Gearbox and a Railcar Hypoid Transmission

A FOUR-SPEED commercial vehicle gearbox, with synchromesh mechanism incorporated in all forward gears, has been introduced by the Automobile Gearbox Division of David Brown and Sons (Huddersfield), Ltd., and is now in general production. It is designated as the model "S450" and was designed for passenger and commercial vehicle application, the prototypes being installed in the Seddon "Pennine" coach with underfloor engine. This gearbox is now available for both passenger and commercial vehicles of 9½ tons capacity, 14 tons maximum loaded weight. It is capable of transmitting a maximum engine torque of 300 lb per foot, and weighs 310 lb with clutch housing. The "S450" box can be supplied with clutch housing as an independent unit for midship mounting. A compact forward control unit, with the control rod mounted on universal joints, allows for variations in layout and permits substantial tolerances in assembly.



Gearbox with Synchromesh on all Forward Gears

Primary, main and lay shafts are mounted horizontally in an unusually shallow aluminium casing, which gives maximum ground clearance without prejudice to a low, uninterrupted floor level. Gears and shafts are of 3½ per cent nickel chrome case-hardening steel, with direct drive top gear. Other ratios are: third gear, 1·87 : 1; second gear, 3·44 : 1; first gear, 6·50 : 1.

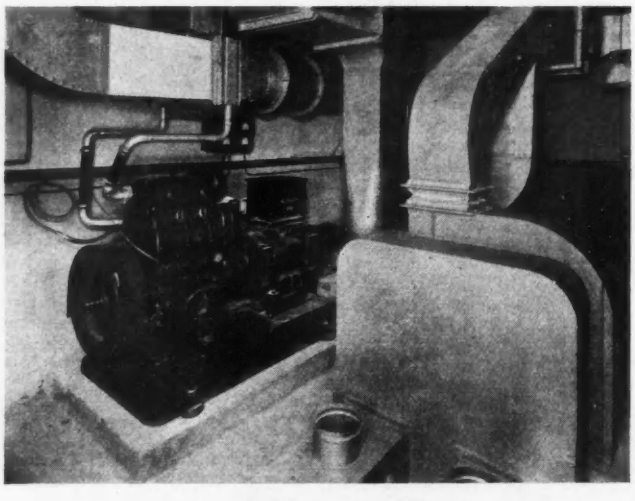
All forward gears have single helical teeth, in constant mesh, with a sliding spur gear for reversing. Gear teeth are hobbed, shaved after lapping and lapped after hardening. A roller bearing supports the primary shaft and a location bearing takes the axial load from the single helical gears. Another roller bearing in the centre wall of the gearbox carries the forward end of the midshaft, which is located at the rear by a deep groove ball bearing. Three roller bearings provide the mounting for the layshaft and an additional duplex ball bearing takes the end thrust from the single helical gears, the reverse shaft being carried on two lipped roller bearings.

Two rows of needle rollers provide the mounting for the third speed mainshaft gear, while first and second gears are carried on large double roller bushes. All gears and bearings are splash lubricated. A standard facing provides for the fitting of a power take-off unit and, if required, a facing can be added at the rear end to take the auxiliary drive for a high-pressure brake pump.

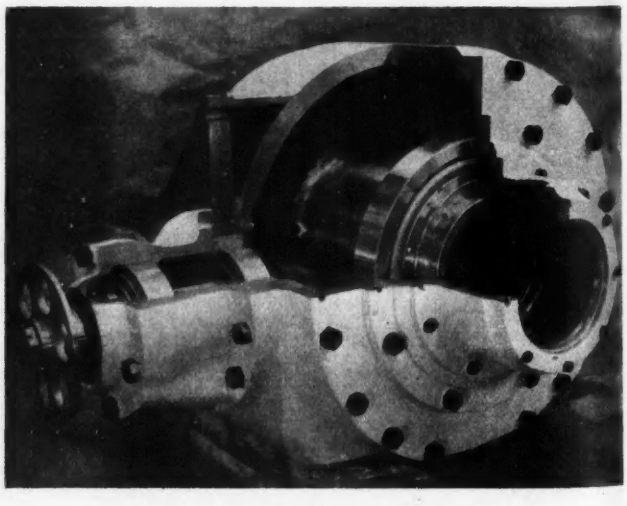
HYPOID TRANSMISSION

The same firm, we learn, recently completed delivery of more than 400 railcar axle transmission boxes, which are being used on a fleet of rapid transit cars being built by the Gloucester Railway Carriage and Wagon Company, Ltd., for the Toronto Transportation Commission. These hypoid gear assemblies, one of which is illustrated on this page, are designed for use with a 65 h.p. motor, giving a maximum speed of 55 m.p.h. The gear ratio is 7 : 52, the wheel having a pitch circle diameter of 20in.

Both the hypoid gear and the pinion are made from high-quality nickel-chrome, case-hardened steel, the pinion, which is forged solid with its shaft, being carried in a cast steel housing. The bearings are accurately positioned by a steel distance piece, with the length carefully adjusted to give the requisite preload for each shaft and housing assembly. A forged steel centre, to which the hypoid gear is bolted and dowelled, is extended at each side to form a sleeve and is mounted on roller bearings. This method of



Generating Set in a Civil Defence Underground Control Centre



Arrangement of Hypoid Axle Transmission

construction enables the complete unit to be pressed on to the axle without dismantling, thus simplifying assembly in the car frame.

The main casing forms an oil bath and, as the gear revolves, oil is directed into the pinion bearing housing, whilst the gear bearings are lubricated by oil thrown off and collected in pockets formed on the bearing housings. An inspection cover incorporates a ventilator, and a combined oil filler and oil lever gauge is fitted to the rear of the casing.

In the manufacture of these transmission boxes the company for the first time in this class of product fabricated the cases from steel plate. The cases are built up by the welding together of twenty-four pieces of mild steel plate in varying thicknesses from 1¼in to 2½in. By adopting this method of construction it was found that welded cases were both cheaper and lighter, that they offered fewer machining difficulties, and enabled a greater degree of accuracy in assembly.

Refuse Disposal Plant at Port Glasgow

A PHOTOGRAPH we reproduce on this page shows part of a new refuse disposal plant installed at Port Glasgow by Heenan and Froude, Ltd., of Worcester, to replace a refuse destructor built some fifty years ago. The old destructor was capable of dealing with about 25 tons of refuse a day, whilst the capacity of the new plant is 40 tons of household refuse in eight hours.

In the new plant vehicles run up an approach road on to a tipping floor and discharge their loads into a large reception hopper of steel plate construction. The bottom of this hopper is formed by a slowly moving plate conveyor which at a controlled rate delivers the refuse to the tail end of an elevating belt. This elevator serves to deliver the crude refuse to a screen and it has an electro-magnetic head pulley for removing the scrap metal.

The cylindrical screen is fitted with renewable perforated metal plates, through which the fine materials fall into a storage hopper below, whilst the refuse is being propelled through the screen by an internal spiral acting as a conveyor and an agitator. The dust hopper has a capacity of 10 tons and is high enough to facilitate loading of collection vehicles.

From the rotary screen the remainder of the refuse is carried on a conveyor through the salvage room. This conveyor, running at about 50ft per minute, is designed as a picking belt, and arranged to display the tailings conveniently to the men stationed alongside for removing salvable materials such as rags, paper, bones, &c.

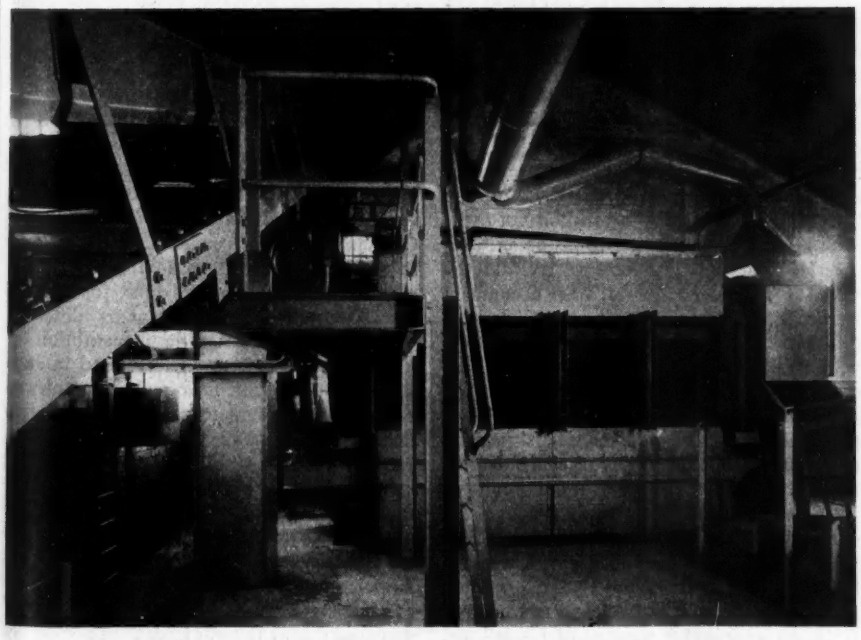
The salvage recovery belt terminates at a three-way distributing chute for delivering the tailings to incinerator cells. A simple arrangement of valves in the chute allows the operator to feed the tailings into any one of the three cells according to requirements.

The incinerator consists of three cells of flat grate design complete with a forced draught combustion chamber and dust catcher. The combustion chamber ensures thorough mixing and combustion of gases from the burning refuse and also acts as a cremator for condemned meat, carcases and other bulky articles. A flue connects the dust trap with a firebrick-lined chimney 100ft high.

The clinker is raked into a water trough running the length of the cells, where it is cooled and quenched. A scraper conveyor runs in the trough and elevates the clinker into a raised storage hopper in the yard.

The electro-magnetic pulley at the head of the main elevating conveyor extracts tins and other ferrous metals from the crude refuse, and these are led by chute to a bin located near a baling press at ground level. This Heenan all-geared, triple-ram baling press has a large filling box which takes large bulky objects, and makes bales of a convenient size for handling.

Throughout the new building in which the plant is housed atmospheric pollution is avoided by the installation at appropriate points of dust-collecting hoods, which are connected by ducting to two suction fans and filter apparatus.



Elevating Belt, Dust Screen and Picking Belt at Port Glasgow Refuse Disposal Plant

American Shipbuilding Contracts for Foreign Yards

(By Our American Correspondent)

OF late there has been much concern in American shipbuilding circles over the increasing number of vessels which are being constructed in foreign yards, although they will be ultimately owned or controlled by American companies. A recent survey shows that shipbuilding contracts placed abroad by United States and affiliated interests in the post-war years now total 261 vessels of 5,273,034 deadweight tons, equipped with propulsion machinery aggregating 2,334,060 h.p. The placing of these contracts abroad is sorely felt by American shipyards, and it has been claimed that if only half of these orders had been placed in the United States, the shipbuilding industry would be in a flourishing condition. All the vessels ordered abroad will fly foreign flags upon completion, being registered principally in Liberia and Panama. However, a certain number will be registered in Honduras, Great Britain, Holland, France, Norway and Italy. It is expected that this post-war trend of ordering new ships from foreign shipyards will continue and that additional contracts will be placed in the next few years if world conditions warrant. One of the principal factors contributing to this situation is the vast increase in the amount of imported raw materials required by the United States since the end of the war. While the importing of all kinds of basic materials has experienced great increases compared with pre-war figures, the biggest volume increases have been in iron ore, bauxite ore and oil, and this movement is likely to continue.

The latest increase in the total of orders placed abroad has been mainly in the field of oil tankers. Thus 80 per cent of the total tonnage ordered involves oil tankers, which account for 191 vessels of 4,427,050 tons. Large bulk ore and bauxite carriers total twenty vessels of 498,850 tons, while dry cargo ships add up to thirty-eight vessels of 334,560 tons. The large majority of these 261 vessels ordered from shipyards abroad are of very large trans-oceanic design, most of the oil tankers being of the "super-size" class ranging up to 45,000 tons. It is of interest to note that more than 40 per cent of these vessels have been ordered from shipyards in the U.K., totalling 114 vessels of 1,951,720 tons with propelling machinery of 833,120 h.p. German shipyards have secured the second largest percentage of the total orders, amounting to fifty-seven vessels of 1,211,810 tons and including three 45,000-ton oil tankers. Japan received the third largest total of the orders, amounting to twenty-seven vessels of 801,600 tons.

The decline during the past year in ocean shipping volume has depressed freight rates both for dry cargo ships and tankers. This, in turn, is having an effect upon long-term charter rates, particularly for tankers. This decline in freight volume has caused the cancellation of some shipbuilding orders in Germany and the United Kingdom, but none of the orders placed by United States and affiliated interests have been terminated. It is expected, however, that fewer orders will be placed abroad during the coming year. The principal reason why so many United States and affiliated interests have ordered so many merchant vessels from foreign shipyards is, of course, the cost factor. The higher cost of labour and materials in the United States makes it practically impossible for American shipbuilders to compete in the world shipbuilding market. It is presumed that the cost factor was the principal reason why a company like the Aluminum Company of America has ordered seven bulk bauxite carriers abroad, four in the U.K. and three in Sweden. If it had been planned to operate the vessels in the coastwise trade of the United States it would have been necessary to construct the ships in American shipyards as this trade is restricted by law to American-built vessels flying the American flag. However, these particular ore carriers will operate from a foreign port to Gulf ports of the United States. Therefore, they can fly a foreign flag, be registered in a country like Panama, and utilise foreign crews. Similar reasons must have motivated the M. A. Hanna Company of Cleveland in ordering two 32,000-ton bulk ore carriers from British yards. Three 60,000-ton bulk ore carriers are being built at the Kure shipyard in Japan, for the National Bulk Carriers of New York. It is believed that these will be the largest cargo vessels in the world and will only be exceeded in overall length by four transatlantic passenger liners—the "United States," "Queen Mary," "Queen Elizabeth" and the "Liberté." They will haul ore from Venezuela and Canada to the United States. The keel for the first one of these three vessels was laid in May and it should be completed during the summer of 1954.

CANADIAN CONFERENCE ON PRESTRESSED CONCRETE.—A conference on prestressed concrete was held at the University of Toronto on January 28th-29th last. The various papers presented were principally by Canadian engineers, but several authorities from other countries contributed papers as well. Various aspects of the subject were covered, including prestressed concrete theory, research and quality control of concrete and steel.

THE ENGINEER

Vol. 197 FEBRUARY 19, 1954 No. 5117

LEADING ARTICLES—

Agricultural Machinery Problems 282
Road Building Policy 282

ARTICLES—

Air Conditioning and Power Plant for Civil Defence Centres. (Illus.) 280
American Shipbuilding Contracts for Foreign Yards 281
Atomic Energy Authority 265
Canadian Building Research Centre 295
Class "25" 4–8–4 Locomotives for South Africa. (Illus.) 275
Commercial Vehicle Synchromesh Gearbox and a Railcar Hypoid Transmission. (Illus.)... 280
Continental Gas Turbines in 1953. (Illus.)... 272
Demonstration of Pneumatic Tools. (Illus.)... 290
Dual-Current Rectifier for Welding. (Illus.) ... 294
Electro-Heat and Prosperity 265
Flood Control Works on the River Welland. No. II. (Illus.) 267
Foundation Problem 265
French Locomotive Experiences. No. I—"The Golden Arrow"—Part I. (Illus.)... 269
Future of British Coal... 265
Hand-Operated Starters for Fractional Horse-power Motors. (Illus.) 293
Improved Ceramic Insulating Material. (Illus.) 289
Magnetic Amplifier for Educational Use. (Illus.) 292
Multiple Purpose Machine. (Illus.)... 294
P. and O. Liner "Arcadia." No. I. (Illus.) ... 279
Pipe Flanges Research... 278
Progress of the European Economy 265
Range of Small Gas Turbines. (Illus.)... ... 285
Refuse Disposal Plant at Port Glasgow. (Illus.) 281
Rotating Shaft Seals. (Illus.) 293
Safety in Ironfoundries 265
Street Lighting and Road Safety 265
THE ENGINEER Buyers Guide 284
Threading Machine for Small Components. (Illus.) 293
Three-Power Decisions on Atomic Energy Information 290
Tugela Basin Development, Natal 277
Turbine Lubricating Oil Purifier. (Illus.)... ... 294
Two Special Machine Tools. (Illus.) 292
Ultrasonic Flue Dust Elimination. (Illus.) ... 291

LETTERS TO THE EDITOR—

Improving Modern Locomotive Performance... 284
Traction Engines 284

LITERATURE 283
Books Received 284

NEWS AND NOTES—

African Engineering News 295
British Patent Specifications. (Illus.) 299
British Standards Institution 290
Continental Engineering News 296
Forthcoming Engagements... 300
Industrial and Labour Notes 297
Notes and Memoranda 298
Personal and Business 298
Technical Reports 300

AGRICULTURAL MACHINERY PROBLEMS

Last week, the fourth National Power Farming Conference was held at Cheltenham. It brought together a company numbering about 1000, which included agricultural engineers, machinery dealers, farmers and students from all parts of the country. The main purpose of the conference was to provide an opportunity for discussion of some of the many aspects of mechanised farming, the emphasis throughout being on the fact that the success of a policy of greater food production is dependent upon successful and increasing co-operation between farmers and engineers. We do not doubt that all who were able to attend the conference found it worth while, for there was certainly a full and frank exchange of views. The discussions were initiated by short papers, and during the two and a half days of the conference, thirteen papers were presented. They dealt with such matters as manpower and machines, grain handling and storage, machinery for hill farming, land drainage, machinery for corn and root harvesting, electricity in agriculture, German machinery design, the economics of machine ownership, and machinery manufacturers' problems. The discussion on each of the papers elicited much that cannot fail to prove of value to engineers and farmers alike.

Strictly from the engineer's point of view, however, we feel that the conference kept the best wine until last! The final paper was a challenging one by Mr. Brooks McCormick, who examined some of the problems which machinery manufacturers must face to-day. He pointed out that the genesis of a new machine might be the result of any one of a number of factors, and went on to elaborate the processes through which a machine must pass before the production stage is reached. Quite rightly, Mr. McCormick emphasised the importance of development work and testing, and he did not hesitate to urge, in that connection, that the "interest, view and criticisms of the sales department" should be taken into consideration. He emphasised, too, the imperative need for manufacturers to keep in mind that agricultural machinery must be so designed that it will do the best possible job under the largest possible number of conditions. Mr. McCormick also reminded the conference that "during the time of field testing the original prototype and subsequent preproduction models, many months probably have elapsed, hundreds of detail changes will have been handled and thousands of hours of actual work spent in the field." Even now, it is not always easy for the users of agricultural or, indeed, any machinery to appreciate to the full the extent of the task accomplished by engineers in the period which must elapse between the design and the completion of a product. The success of agricultural mechanisation is very dependent upon the provision of well-tested equipment which is as perfect in design, construction and operation as engineers can make it after full consideration of all the "variables." Mr. McCormick did not overlook this important matter in his paper. He asserted that both in this country and the U.S.A. the second world war brought a sudden termination to farm machinery development, and that after the war a huge pent-up demand for the then existing models did not compel any speeding up of engineering and development work. In short, he suggested that in the days of the sellers' market, there may not always have been sufficient thought given to the users' real requirements, with the result that there set in amongst the designers and manufacturers of agricultural machinery "an acute attack of complacency." Such a forthright expression of opinion from a machinery manufacturer may not call forth the unanimous support of his fellows, but we believe it will help them to keep in mind, in these more competitive days, the need to look carefully to quality in machinery design and production.

In some places, it has been hinted that agricultural mechanisation has about reached its peak, but there is little sound evidence for any such assumption. The population of this country is growing, and an intensified agriculture must be practised if food production is even to be maintained at its present level, let alone increased. In addition, of course, there are vast areas overseas that are steadily being reclaimed and developed in order that world food supplies may be made more secure. It is quite true, especially of some overseas countries, that some farming methods have not changed much for scores of years. Their modernisation cannot be brought about without the patient and determined effort of engineers, and in such a work British engineers are well fitted to take a large part. The value of this country's agricultural engineering output is now running at well over £100 million a year, and a big proportion of that output is being sold overseas. To maintain and improve upon what has already been achieved still calls for the quantity production of machinery, but, in an increasingly competitive world, it calls also for the most careful attention to quality production. Last week's excellent conference at Cheltenham gave some fresh emphasis to this matter. The machinery designers, manufacturers and dealers illuminated some of their problems and their hopes, the machinery users did the same. The outcome must be an even greater determination on the part of all who are concerned in the world mechanisation of agriculture to keep vigorously alive a partnership which has already accomplished so much that is valuable.

ROAD BUILDING POLICY

To what remarkable shifts are Government spokesmen reduced in attempting to justify a policy of doing far too little to improve this country's roads! Mr. Molson, in last Monday's debate in the Commons, even attempted to establish "that the British road system, however much it has been criticised, is still the best in the world." No doubt, in one sense the remark is true. As compared to the rest of the world, this country is, indeed, blessed with a network of secondary and minor roads that is remarkably good. But the standard of its main roads and its trunk highways is quite another matter. There this country is falling well behind other nations of Western Europe. Certainly its trunk roads are not "the best in the world"! Nor is anything of appreciable importance being done to improve them. On the Continent it is different. When the members of the Institution of Mechanical Engineers visit Holland in June they will, no doubt, have an opportunity to see some of the great double-lane highways that relatively small country is affording. Western Germany, as Mr. Noel Baker mentioned in the debate, is planning no less than 3500 miles of new motorways at a cost of £35,000,000 a year. France has an excellent system of roads bequeathed by Napoleon and adequately modernised for the traffic they bear. In Italy roads severely damaged during the war have been not merely restored, but improved. London, accord-

ing to Mr. Noel Baker, is the only Western city (Did he mean capital ?) " where there are no modern techniques—arterial roads for motor traffic, flyover junctions, proper parking places and the rest." Nor does another of Mr. Molson's propositions ring true. How many road engineers would agree with his statement that " the rate of maintenance of our roads since the war has been very nearly adequate," unless, indeed, the meaning of " nearly " is intolerably stretched?

Naturally there was much reference in the debate to road accidents. But even there Mr. Molson was driven, in attempting to justify Government policy, to support the proposition that " although road defects are responsible for a certain number of road accidents, there are many other causes which account for the majority of them." Again, so clever are politicians at making equivocal statements, it is one that could be supported in argument. For it is obvious not only that some accidents, as, for example, those in which intoxicated road users are involved, cannot be prevented by road improvement, but also that if only people could be made to behave better and more carefully on the roads there would be very many fewer accidents. What is forgotten is that the education of road-users is a slow and uncertain process; whereas road improvement, by heavily reducing the opportunity for human misjudgment, makes a very direct contribution to the reduction of the number of accidents. Furthermore, another point made by Mr. Noel Baker, expenditure upon the roads not only reduces accidents, it reduces congestion, too, thereby, incidentally, also encouraging better road behaviour. Indeed, as Mr. Lennox-Boyd has more than once admitted, the economic argument for road improvement is even stronger than the humanitarian. Exactly how much death and injury on the roads, delays to traffic, and unnecessary wear and tear to vehicles costs the country is difficult to estimate. Several differing estimates have been made by different people. But the exact figures calculated are not important. What is important is that all estimates, however made, seem to put the annual loss at somewhere between £100 million and £150 million at present prices. Yet, again to quote Mr. Noel Baker, all that the Minister proposes to spend amounts to " an annual capital investment of one-tenth of the annual loss."

Capital expenditure of £50,000,000 will be approved (not spent) during the next three years, and it is hoped to continue actual expenditure thereafter at £14,500,000 a year. It would be, of course, unreasonable to expect a great capital investment programme upon roads to be started up at once. First it will be necessary to build up the labour force and acquire the roadmaking machinery. But is what Mr. Molson called the " plateau level " expenditure of £14,500,000 a year nearly high enough ? Is it even sufficiently high to encourage the making and the purchase of sufficient roadmaking machinery? The debate seemed to us to show clearly that it is not. For member after member, speaking for his constituency, pleaded the urgency of road works in all parts of the country. Far from the Government being attacked for spending so much, it was being condemned for spending so little. Its answer was that the country could not afford it. But when somebody affirms that he cannot " afford " this or that, what he really means is that he prefers to spend his money on something else. If, therefore, the people of this country really want better roads they can have them. Temporarily they will have to do without something else. But in our view, both on economic and humanitarian grounds, it would pay them to invest in better roads. For the prospective return on the investment is very high indeed. Nor does it seem sensible to preach the virtues of better methods of materials handling within the factory gates and to neglect to improve transport outside them. It is, in fact, untrue that this country cannot afford to spend more than the Government plans upon the improvement of its roads. It would be more truthful to say that it cannot for very much longer afford not to spend substantially more.

Literature

Numerical Analysis. By D. R. HARTREE. London : Oxford University Press, Amen House, Warwick Square, E.C.4. Price 30s.

THE average engineer, when calculating with a slide rule or plotting results on a graph, is probably unaware that he is engaged in " numerical analysis." There will, in fact, be many who have only a hazy idea of what is involved in this subject and no knowledge of its theory or practice. *Numerical Analysis* is the title of a recent book by Professor Hartree. The author is Plummer Professor of Mathematical Physics at Cambridge University and he has based his book on a course of lectures given in the Mathematical Laboratory at Cambridge. The stated purpose of the book is to give an introduction to the subject to those who have to carry out calculations in the field of pure or applied science.

The opening chapter first of all carefully explains what numerical analysis is—and what it is not. It is defined as the science and art of numerical calculations. It is concerned with the processes of obtaining numerical results, not with the results themselves. Although the processes produce the results as numbers, algebra and analysis are involved in their development Numerical analysis must not be confused with the theory of numbers; nor is it related to statistical analysis. The main types of operation that have to be carried out in the course of numerical analysis are listed. They form the subject matter of subsequent chapters. This first chapter ends with a discussion on errors and accuracy. Processes for numerical checks in the stages of the calculations form an important feature of numerical analysis.

The tools of numerical work are considered in the next chapter. They comprise desk machines, tables, slide rule, graph paper. The main types of calculating machine are described with an outline of their methods of operation. They are cited as the most important single tool for numerical work. A distinction is made between those which are simply " adding machines " and those which perform multiplication processes directly. Brief mention is made of other " tools," including a list of important tables, and finally a method is given for the systematic organisation of a calculation.

The first operation of numerical analysis to be dealt with is " Evaluation of Formulæ." A simple example illustrates the difference between algebraic and numerical analysis : the equation

$$x^2-2xy+1=0$$

gives the algebraic relation between x and y. For numerical work it must be expressed as either

$$y=(x^2+1)/2x$$

or

$$x=y+(y^2-1)^{\frac{1}{2}}.$$

The former gives the process for obtaining y for given values of x ; the latter, the reverse. Methods for the evaluation of polynomials and power series are given and the well-known procedure for obtaining the solution of a quadratic, when the ratio of the roots is large, is included.

As a preliminary for further numerical operations there is a comprehensive chapter on " Finite Differences." This is mathematical and the reader must be familiar with the symbolic representation of Taylor's expansion and the general manipulation of operators. A number of relations are derived between differences and differentials, among which is the familiar " Simpson's rule." There are two minor errors of cross referencing in this chapter : a 4·42 for a 4·43 and a 4·4 for a 4·3. The next chapter on " Interpolation " follows logically. By means of finite difference operators a number of standard interpolation formulæ are derived. Examples of their use are given and the allied subjects of subtabulation and inverse interpolation are covered. The analysis required for obtaining the necessary formulæ is in some cases rather complicated.

The process of numerical integration is covered in two chapters, since a distinction is made between two kinds. The first deals with the integration of a given function of the independent variable—this is called quadrature ; the second considers the integration involved in the solution of ordinary differential equations. For the first the treatment follows the procedure of the previous chapter —that is, the derivation of the necessary formulæ and rules, and their application. Numerical differentiation is also included. For the second the main types of differential equations are considered with alternative methods given for their numerical solution.

The next main kind of operation is " Simultaneous Linear Algebraic Equations." An interesting comment made by the author is : " although there may be no one best way of evaluating the solution, it can be said with some certainty that direct evaluation of the determinant and the expression of the solution in terms of them is *never* the best way." That is, of course, the way that one learns in algebra and, without other knowledge, the way one would use. To follow the various methods that are given the reader must be familiar with matrix algebra. One method that is mentioned is the " relaxation " method developed by Southwell. " Non-Linear Algebraic Equations " are next considered. Among the methods discussed is the Newton-Raphson process, which is more usually known as Newton's method of approximation. Cubic and quartic equations are briefly mentioned.

In the chapter " Functions of Two or More Variables " complex numbers are considered and it is necessary to extend the theory of finite differences to two dimensions, in cartesian co-ordinates and cylindrical co-ordinates, with the introduction of the Laplacian operator. Partial differential equations are discussed, leading to the numerical solution of the important Poisson's equation. The last theoretical chapter on " Miscellaneous Processes " includes harmonic analysis and summation of series.

To complete the book there is a final

chapter on " Organisation of Calculations for an Automatic Machine." This is called programming ; it can be considered a branch of numerical analysis. To give practice in the operations a number of examples are given at the end of the book. A good bibliography is included.

This is not an easy book. The author warns the reader in the preface that, although intended as an introductory treatment of numerical analysis, " it is not elementary in the sense of using only school mathematics." The book is written by a mathematician and it is suitable only for the engineer who is also a mathematician. For one who is able to follow the necessary analysis and has occasion to make use of the processes it provides an excellent textbook on an important subject.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

IMPROVING MODERN LOCOMOTIVE PERFORMANCE

SIR,—I notice in Mr. Nock's article, " Improving Modern Locomotive Performance," in the current number of your paper, there is the statement, " One day a top-link crew may receive first-class Welsh steam coal, the next they will have to run the same train with kitchen cobbles."

What a terrible admission ; surely this is only a question of organisation and could be easily put right, although one has to remember both railways and coal mines are nationalised undertakings, without any real incentive towards doing a good job.

G. W. VICKERS

Sheffield, February 9th.

SIR,—The gist of Mr. O. S. Nock's article under this heading is that the standard blast pipe and chimney of the Western Region " King " class locomotive restricted the power output of the boiler, although, even so, it has apparently been approximately adequate for what the engines have been asked to do for a quarter century. With modifications to the front end, the output of the boiler has been considerably raised, although it is still substantially below what practice elsewhere has shown to be possible in a boiler of that size. To avoid any false impression that there is anything novel about such changes it should perhaps be added that facility in front end design to suit widely different grades of fuel has long been a necessity for builders of locomotives for overseas service.

May I mention that noting an evaporation figure of pounds of steam per hour has only a limited significance ; millions of British thermal units per hour would be a more rational figure. By quoting " no less than 33,600 lb " does Mr. Nock mean that the evidence was so vague that no upper limit can be stated ?

I venture to suggest that certain parts of the article can convey little meaning in the absence of precise definitions of the terms " discharge limit," " draught limit " and " grate limit." The remark in connection with the " Kings " that " the designed power-weight ratio is high " also needs elucidating, especially if a comparison is made with other British locomotives.

The use of accurately controlled blast-orifice pressure as a means of keeping the indicated horsepower constant is perhaps the notable feature of the testing technique described, but it is essential to realise (and the article does not mention this) that this artifice works only so long as the cylinder efficiency is constant. This means (very broadly) that cut-off must be kept between about 15 and 25 per cent, as was the case in these particular tests. This could be done because the route used has only moderate gradients ; on other routes the technique might fail because the upgrades demand a later cut-off than about 25 per cent, and the downgrades produced distracting speeds.

In view of well-established (though unofficial) practice by harassed enginemen, it is surprising to read that " if steaming is unsatisfactory it is unlikely that improvement would result from decreasing the orifice diameter." Surely, if steaming is poor because the orifice diameter is unduly large, a reduction is bound to effect an improvement.

It is surprising also to read the suggestion that only with the recent arrival of accurate testing of locomotives " schedules can be produced rapidly and accurately for any route," the more so because if the subject matter of the article has any bearing on schedule planning at all, it is to raise doubts about its practicability. I refer here to the fact that the coach resistance figures shown in the article are very appreciably lower than those of the Johansen and Davis formulæ for similar stock, and very much lower than some older formulæ suggest. There has always been uncertainty about train resistance, and by bringing it again into prominence these Western Region tests underline what would be the only difficulty in drawing up a rational train schedule on a route for which no running data exist, and so tend to discourage it. Mr. Nock says that it is " essential to give a conservative rather than an optimistic estimate of load-hauling capacity " (a suggestion that British Railways will not find novel), and this applies with even greater force to train resistance.

W. A. TUPLIN, D.Sc., M.I.Mech.E.

Sheffield,
February 13th.

SIR,—A printer's error occurred on page 237 of your issue of February 12th, near the foot of column one, where it reads : " The tests were made on week-ends amid the ordinary traffic." This should have read " on week-days."

O. S. NOCK

Bath,
February 13th.

SIR,—No one would reasonably deny that Mr. S. O. Ell's recent paper represents a notable contribution to the art of locomotive testing as such. Severe criticism has, however, already appeared in these columns of his sweeping extension of this work to claim that the preparation of optimum schedules from locomotive test results has thus been reduced to an " exact science."

Whatever arguments Mr. O. S. Nock may use in support of Mr. Ell, the fact remains that before accepting the truth of such an assertion we are entitled to require, on purely scientific grounds, supporting evidence of an attempt to correlate the test figures on the stationary plant with at least one road test over a variety of different routes which are fully representative of the range of conditions over which this " exact science " is claimed to apply. With all the so-called advantages of unification of our railways at his disposal, Mr. Ell surely had no need to confine his experiments to familiar ground on his own doorstep, which, broadly speaking, represents a single and, indeed, one of the more favourable types of route on British Railways. If he had illustrated his claim with reference also to the preparation of optimum schedules between, say, Salisbury and Exeter or Marylebone and Rugby, as good " switchback " routes, Carlisle and Glasgow over Beattock or Carlisle and Edinburgh via the Waverley route, giving good summits to surmount, and Manchester and Leeds via Littleborough or Dingwall and Kyle of Lochalsh, having miscellaneous hazards restricting optimum locomotive working, we might perhaps be convinced by his arguments.

Both Mr. Ell and Mr. Nock suggest that the effects of junctions and speed restrictions can be allowed for, but it is significant that neither makes any effective move to show precisely how. For an " exact science " should surely be applicable to the majority of cases within its scope. Is it not possible, therefore, that, over at least some of the representative routes mentioned above, the ratio of " allowance " to " science " required would rise to a figure which cast grave doubts on the " exactitude " of the overall result ?

" PYROTECHNIC "

Manchester,
February 13th.

TRACTION ENGINES

SIR,—May I appeal through these columns to any of your readers who may possess information about any make, type or variety of steam traction engines once made by any firm ?

I am preparing a history of the traction engine as made in Great Britain and would welcome the loan of any data. No doubt there are early drawings, leaflets, catalogues, photographs and anecdotes, &c., quite unknown to me and any loaned will be carefully examined and returned intact to the lenders to whom I shall be extremely grateful.

RONALD H. CLARK
A.M.I.Mech.E., Member, the Newcomen Society.

Diamond Cottage,
Shotesham All Saints,
Norwich,
February 11th.

THE ENGINEER Buyers Guide

THE 1954 edition of *The Engineer Buyers Guide* has just been published and one free copy is being dispatched by post to all subscribers on our lists. Arrangements have also been made for all regular readers who obtain THE ENGINEER through newsagents to receive a copy, which should be delivered to them with the current issue. There are now over 20,000 entries arranged under about 1700 classified headings in the " Buyers Guide " section. As compared to the 1953 edition this year's contains an additional section listing United Kingdom agents for foreign firms. Any subscriber or regular reader not receiving a copy should write to The Manager, THE ENGINEER, 28, Essex Street, Strand, London, W.C.2. Extra copies are obtainable at 5s. each, including postage.

BOOKS RECEIVED

Theory and Practice of Structural Design Applied to Reinforced Concrete. By B. Eriksen. London : Concrete Publications, Ltd., 14, Dartmouth Street, S.W.1. Price 25s.

Radio Engineering, Vol. I. By E. K. Sandeman. Second edition. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 60s.

Measurement Techniques in Mechanical Engineering. By R. J. Sweeney. London : Chapman and Hall, Ltd., 37, Essex Street, W.C.2. Price 44s.

An Introduction to Relaxation Methods. By F. S. Shaw. U.S.A. : Dover Publications, Inc., 1780, Broadway, New York, 19, N.Y. 5·50 dollars.

The Manufacture of Iron and Steel. By D. J. O. Brandt. London : The English Universities Press, Ltd., St. Paul's House, Warwick Square, E.C.4. Price 15s.

Engineering Drawing. By Frank Zozzora. London : McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 40s.

Machine Shop Practice. By W. C. Durney. Third edition. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 12s. 6d.

Budgetary Control and Standard Costs. By J. A. Scott. Third edition. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 18s.

The Aircraft Engineers' Handbook, No. I : Airframe Structure and Controls, Flying Instruments and Equipment. By W. J. C. Speller. London : Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, W.C.2. Price 30s.

Range of Small Gas Turbines

Some details are given in this article of the detail modifications now being incorporated in the "Turbomeca" range of gas turbines prior to their production at the works of Blackburn and General Aircraft Company, Ltd. The British versions will employ Nimonic 90, an impeller of stiffened construction and a fuel and control system of more recent development. The higher cycle temperatures envisaged are expected to improve the output and economy of the range, whilst the structural alterations foreshadow a possible increase in overhaul life from 300 to 2000 hours and at the same time enable many components to be common to the range. General details of design and construction are given together with a description of the existing fuel and control system.

WHILE final preparations are in hand for the production of certain models in the "Turbomeca" range of small mobile gas turbines, the Blackburn and General Aircraft Company, Ltd., has for some time now been conducting acceptance and endurance trials on several models in some recently converted test houses at Brough. In the course of a recent visit we saw some of this programme and were able to examine the condition of typical components after periods of up to 800 hours continuous running. It will be recalled that this range of gas turbines was developed under the direction of Monsieur J. Szydlowski and is in production at the works of Société Turbomeca at Bordes (B.P.) in France. The Blackburn and General Aircraft Company, Ltd., acquired the manufacturing rights of this range in the United Kingdom and most of the Commonwealth in October, 1952.

In the table reproduced on the next page are listed some leading particulars of the complete range. The company, however, has in mind the production of only the "Turmo I" and "II" (Fig. 1), the "Palouste" (Fig. 3), the "Artouste I" and "II" (Fig. 2), the "Palas" (Fig. 4), and the "Marbere." It is pointed out also that the capacity and performance of the units listed are taken from the design specification formulated by the parent company; the "Blackburn-Turbomeca" range of engines will give rather higher powers with improved economy due to the use of British materials, particularly the use of Nimonic 90. This material is both very expensive and hard to obtain in France and its incorporation will enable an appreciable rise in the maximum cycle temperature to be utilised and will improve the power, weight and consumption characteristics of the range. At the same time limited modifications will be made to the detailed design, particularly of the static components, of these models, mainly to facilitate their production in this country but also to eliminate some minor defects which have been found during running on the test beds.

We understand that the company hopes by these modifications to make as many basic components as is practicable standard to the whole range, for which a common set of spares can be provided. In certain cases the promise of a much lighter unit has justified more extensive modification, the chief instance being the "Turmo" engine, which was originally designed as a military tank unit to develop 450 h.p. It is hoped to reduce the weight of this engine with its gearbox to 250 lb.

The company has designed and is building a standard gearbox which can give practically any reduction gear down to 1000 r.p.m. according to customers' requirements. This is considered to be a big improvement over the existing 6000 r.p.m. in the case of the French built "Artouste" and makes the engine much more acceptable as the prime mover for generators, &c.

The range of "Turbomeca" shaft turbines extends from 276 h.p. to 450 h.p., the basic design concept being retained in all engines. The rotor assembly is common to several of the units and the cycle includes single-stage, centrifugal compression, a particularly compact annular combustion chamber and single or two stage turbines. The shaft drive is either an extension of the compressor turbine shafting or is separate from it and driven by a free turbine. The maximum typical shaft speed is 35,000 r.p.m.

A section drawing reproduced in Fig. 5 represents the "Palouste" air compressor set which is a combination of the "Artouste" and "Palas" units but employs the larger impeller of the "Palas." In this particular unit the air mass flow divides after the compressor, there being 139 lb per minute of free air available at 41·2 lb per square inch gauge at 15 deg. Cent. The mass flow of the thermal cycle is 4·25 lb per second. With the "Palouste" as with the other units in the range, the impeller is machined from a light alloy drop stamping. A separate light alloy inducer is secured on the shaft by shrinkage and to the impeller boss by dowels.

Our illustration in Fig. 6 shows the profile

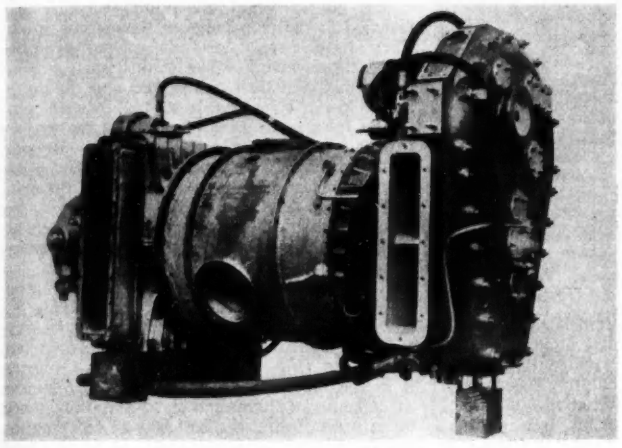


Fig. 1—"Turmo II" Free Power Shaft Turbine Developing 450 h.p.

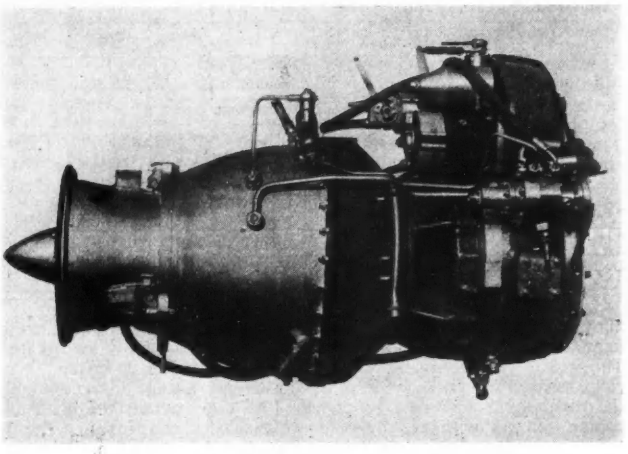


Fig. 2—The "Artouste" Fixed Shaft Turbine

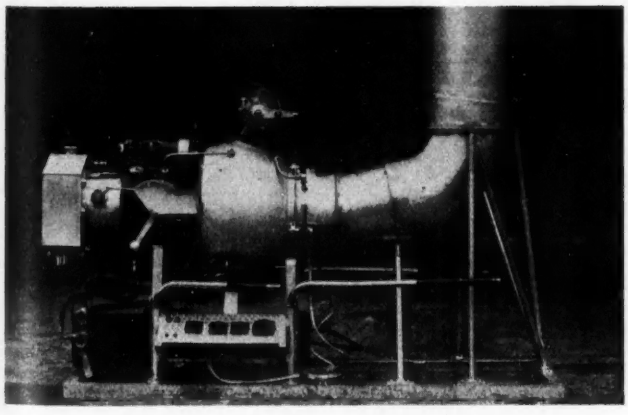


Fig. 3—The "Palouste" Showing the Light and Transportable Mounting

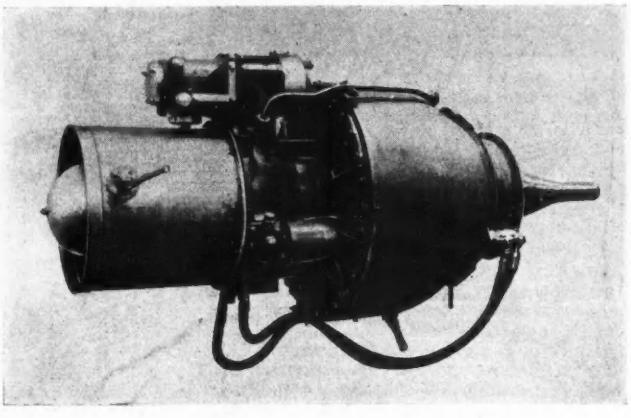


Fig. 4—The "Palas" 350 lb Thrust Turbo-Jet Engine

milling operation on the inducer or pre-swirler as adopted by the parent company. The Blackburn company, however, has not yet finalised the technique which it will adopt on this component.

A radial and an axial diffuser stage will be noted on the drawing below. The blades in the axial diffuser are machined internally from a light alloy ring which is bolted in three sections to the joint of the compressor and central casings. The radial diffuser is formed from two flat rings between which the guide vanes are welded, the assembly thus formed being bolted to the compressor casing flange by bolts which also secure the diffuser cover disc. This disc carries the internal shroud ring of the axial diffuser and incorporates at its bore a labryinth seal. A central casing shrouds the combustion chamber and turbine stages which is of welded sheet metal construction and in the case of the "Palouste" is double-walled. The inner wall is perforated for the passage of the air in excess of the thermal air mass flow requirements, whilst the outer wall embodies one bleed port for the compressed air supply.

Two concentric sheet metal assemblies form the annular combustion chamber, which is common to all units. The outer "can" has three main parts which are shown separately in Fig. 8; a forward disc acting as a turbulence baffle plate which is welded on to a collar attached to the diffuser cover; a rear disc bolted to the first stage nozzle assembly, and a closing sheet which admits the main dilution stream through holes and tubes. The joints permit free thermal expansion. Details of the inner "can" can be observed on the right background of Fig. 8 and on the drawing below, the baffle plate and the bridging plate being welded to the labyrinths. The rear extension of the baffle plate is free to slide in contact with the inner annulus of the first stage nozzle assembly, shown separately in the right foreground of Fig. 8, and the whole assembly together with the first stage nozzle casing can expand a distance of 0·040in axially. Minor welding failures have occurred at certain points of this unit and some modifications have been incorporated. Following the appearance of small radial cracks in the inner "can" during the present tests the circumferential stress relief grooves shown clearly in Fig. 9 have been extended to the second hole ring.

An example of the original arrangement is shown in Fig. 9 after 600 hours, cracks having occurred in both elements of the chamber.

In the first stage nozzle assembly, shown in the right foreground of Fig. 8, the stators are hollow blades which pass through slots in the inner and outer casings to which they are welded externally. The blades themselves are formed from plate and welded spanwise.

Air required in the thermal cycle splits into three streams. The front combustion stream penetrates into the chamber through the front turbulence baffle, the slots in which are pierced so as to face in opposite directions in alternating rows in order to secure maximum turbulence. The rear combustion stream penetrates into the chamber through the rear baffle formed by the inner "can," this air having first passed through and cooled the first stage hollow stators. As already noted, the main dilution stream enters the chamber via the holes and tubes in the outer "can."

The nozzle stages are bolted together and fastened to the rear flange of the central casing. They have twenty and twenty-seven nozzle blades, respectively. The second stage nozzles are formed and their tips slotted into the casing and welded. The roots are secured by welding.

The turbine stages in this unit have twenty-five and thirty-three blades machined integrally with the discs from solid forgings. The maximum inlet temperature common to all the units is 800 deg. Cent. and, as already stated, the company intends to use rotors of Nimonic 90. The diameter of the rotors throughout the range varies from 7·9in to 10·38in.

A hand operated profile milling machine is employed in the French factory for milling the rotor blades. The former and part of the pantograph reduction linkage can be seen in our illustration (Fig. 7). The Blackburn Company is at the moment experimenting with a similar machine on an aluminium blank and on Nimonic 90 in order to find the best way of reducing the profile milling time required. In preparation for this machine (and incidentally to reduce the metal which has to be removed by the profile milling machine) radial serrations, the depth of the blade at blade pitch in an oblique axial direction, are made on a standard milling machine.

The rotating assembly (shown in Figs. 5 and 10)

Some Characteristics of the "Turbomeca" Range

Air Compressors	Maximum output: Free air	Maximum output: Fuel cons., lb/hr	Weight, lb	Overall dimensions: Length, in	Overall dimensions: Width, in	Overall dimensions: Height, in
Palouste	139 lb/min. at 41·2 lb/sq. in. gauge at 15 deg. Cent.	275	187·5	41·7	18·66	19·67
"Arrius I"	167 lb/min at 31·6 lb/sq. in. gauge at 15 deg. Cent.	247	291	53·5	20·65	21·95
"Arrius II"	231 lb/min.	N.A.	290	56·5	20·7	22

Shaft turbines	Max. conds.: Power, h.p.	Max. conds.: Spec. fuel cons., lb/h.p. hr	Max. cont. conds.: Power, h.p.	Max. cont. conds.: Spec. fuel cons., lb/h.p. hr	Air mass flow, lb/sec	Press ratio (max.)	Weight, lb	Overall dimensions: Length, in	Overall dimensions: Height, in
"Artouste I"	276	0·960	226	1·02	4·75	3·7 : 1	183	36·6	23·2
"Artouste II"	394	1·0	325	1·08	6·8	3·7 : 1	200	41·35	21·5
"Turmo I"	270	1·03	235	1·08	4·75	3·8 : 1	200*	45·1	27·2
"Turmo II"	450	1·0	325	1·2	N.A.	N.A.	260*	47·31	23·19

* Without reduction gear.

Jet engines	Max. take-off conds.: Thrust, lb	Max. take-off conds.: Spec. fuel cons., lb/lb thrust/hr	Max. cont. conds.: Thrust, lb	Max. cont. conds.: Spec. fuel cons., lb/lb thrust/hr	Air mass flow, lb/sec	Press ratio, (max.)	Weight, lb	Overall dimensions: Length, in	Overall dimensions: Max. dia., in
"Palas"	350	1·17	290	1·10	6·85	3·9 : 1	159	47·2	15·95
"Marbore"	883	1·15	706	1·07	16·73	3·9 : 1	309	43·1	22·3
Ducted fan : "Aspin II"	795	0·545	662	0·510	48·6	3·6 : 1	306	63·5	23·8

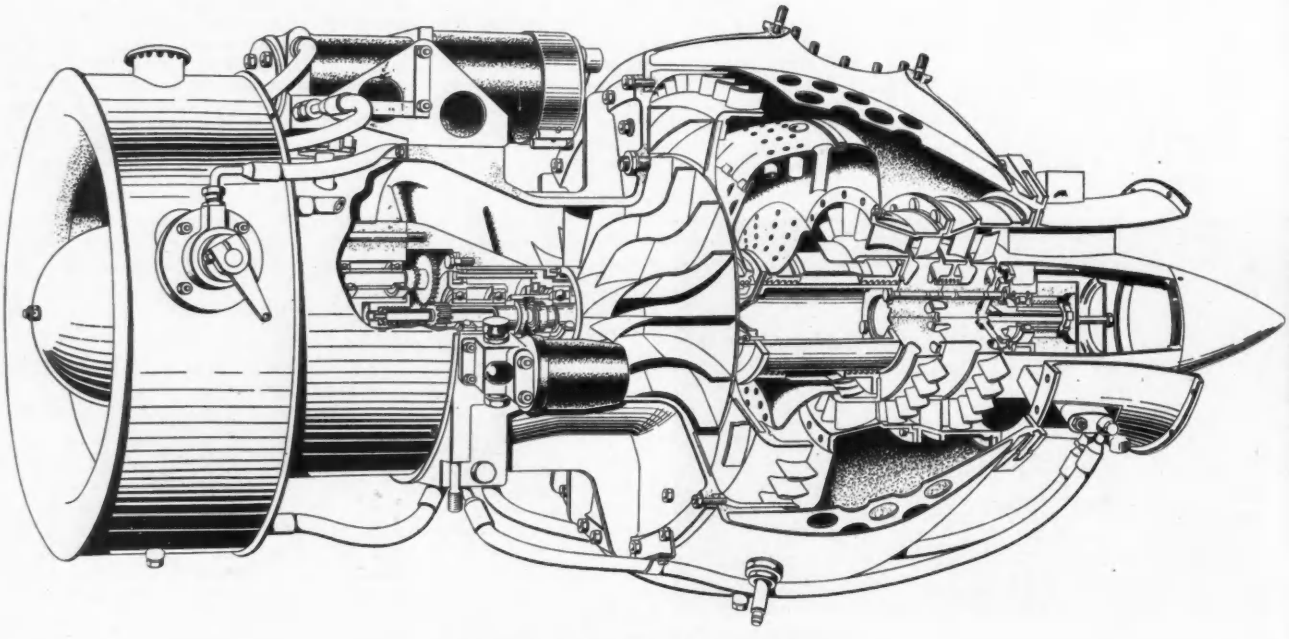


Fig. 5—The "Palouste" Gas Turbo Compressor

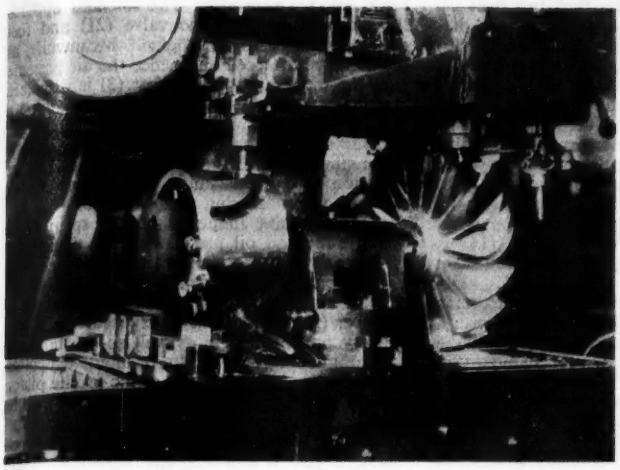


Fig. 6—Copy Milling the Prewhirler

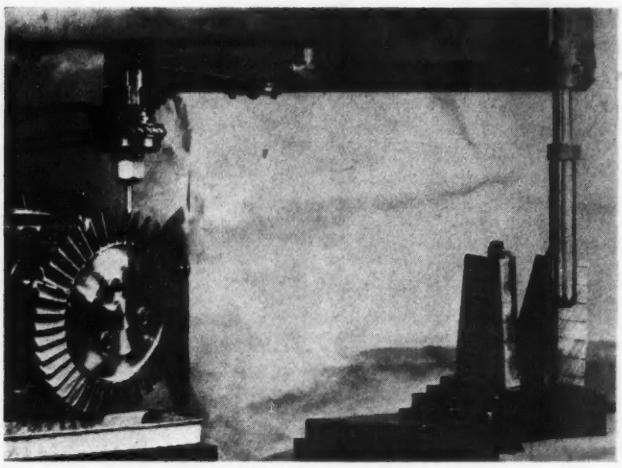


Fig. 7—Copy Milling the Turbine Rotor

rests on a ball race at the front and a roller race at the rear. Inner and outer diverging cones form the exhaust diffuser and three ducts shrouding the rear bearing support spider and transfer block are welded on to the cones as well as the thermo-coupled mounting bosses and the rear bearing cooling gas exhaust ducts.

The front face of the turbine shaft flange has radial grooves which ensure the circulation of the air during operation. The air is drawn in through the ducts and the hollow turbine stub shaft, and is centrifuged and discharged between the sets of sealing labyrinths from where it escapes through holes in the collar and inner exhaust duct to atmosphere. This flow is assisted by the induction effect of the exhaust stream. The engine is supported kinematically from three trunnions.

It is emphasised that the minor defects of the kind noted previously, occurred after running periods considerably in excess of the overhaul life of the engine which in France stands at the moment at 300 hours. The modifications which are envisaged are expected to give a useful extension of this figure, the target for overhaul life being 2000 hours. Cases of compressor failure due to vane fatigue have also occurred at relatively advanced stages of the engine test life and a slightly heavier construction will be adopted by the British company, including the use of a steel prewhirler. The need of steel in this component is generally recognised in this country. So far no failure has been due primarily to bearing failure. Isolated cases of vibration, however, have been shown to be due to original defects in the manufacture of the bearings which are not likely to occur with units manufactured in this country.

Fuel and Control Systems.—In past descriptions of gas turbine sets details of the fuel system have largely been omitted and the opportunity is taken here of describing more fully both the governing and metering systems embodied in this particular range of engines, the principle of which is common to all the French designed units.

This whole system is, however, now in the process of extensive redesign which is being carried out in conjunction with Joseph Lucas (Gas Turbine Equipment), Ltd., in preparation for the production of these models here. A torch igniter system has removed the necessity for a bi-fuel arrangement and the company have already carried out engine tests using diesel oil. It is also intended to employ a quartz rod jet pipe temperature control system, as fitted to certain aeronautical gas turbines in this country in order to make foolproof operation of the engines by unskilled personnel. In conjunction with the Admiralty the company has also devised a hand starting system, which when coupled to a hand started magneto, eliminates the need for such electrical equipment as starter motors, accumulators, &c.

The existing fuel and control system is represented diagrammatically in Fig. 11. The fuel supply is controlled by a governor which limits the flow as a function of rotating speed, and to prevent turbine over heating during starting and acceleration there is an additional metering system which restricts the fuel air ratio under these conditions.

The fuel is filtered before reaching the fuel pump, the latter having a capacity of 80 gallons per hour at 28·5 lb per square inch, and incorporating an externally adjustable pressure release valve. It is then pumped via a fuel control cock to the governor controlled metering valve.

Speed Governor.—The governor is mounted on the rear face of the accessory casing. Its servo pump is driven from an accessory drive and is supplied through internal drillings. The distributor sleeve which carries the governor weights is driven from the same shaft through the pinion at its other end. Ports in this sleeve are alternatively covered and uncovered by the motion of the distributor piston which is operated by the governor weights. A spring, the loading of which may be adjusted by the governor control lever, counter balances the governor weight action.

When the turbine speed tends to decrease due to the application of load, the distributor piston will move to the right and port (*a*) is put into communication with (*d*). The centring

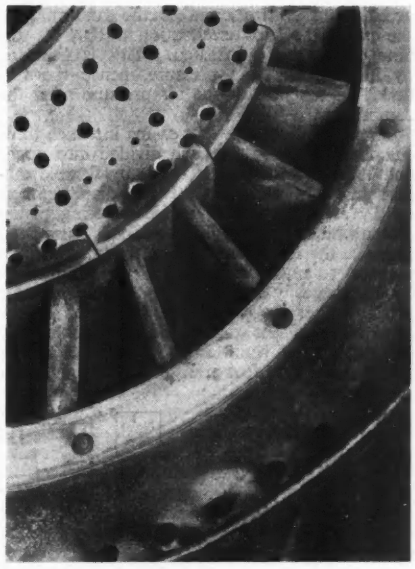


Fig. 9—The Inner Can, Rear Disc and Nozzle Assembly

piston moves to the left, and as the oil in the circuit between this piston and the metering needle cannot readily escape through the jet (*e*) the metering needle moves to the right, increasing the fuel supply and hence the revolutions per minute. Oil displaced by this needle is returned to the tank through port (*b*). As the speed increases the distributor piston moves to the left, which closes the communication between (*a*) and (*d*) and allows oil to pass from (*a*) to (*b*). The metering piston then moves to the left, thereby reducing the fuel flow and hence the revolutions per minute. Oil displaced by this movement causes the centring piston to move to the right and oil from this cylinder escapes through the port (*c*). Eventually the distributor piston attains an equilibrium position as illus-

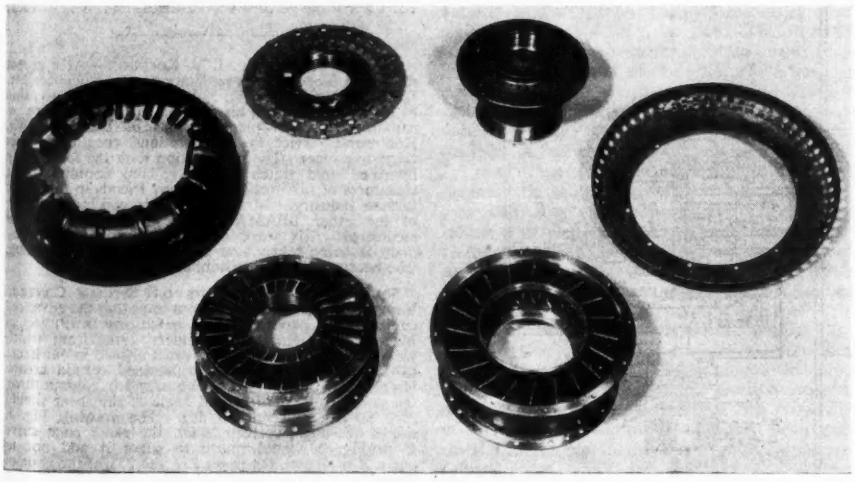


Fig. 8—Components of the Inner and Outer Concentric Combustion Cans and the Second and First Stage Stator Casings

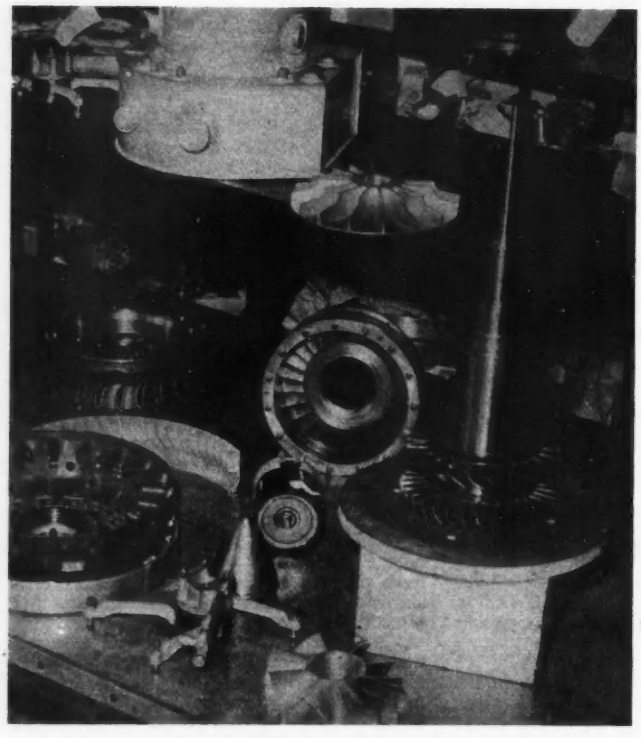


Fig. 10—The Impeller, Inducer, Rotors and Shaft, First and Second Stage Rotor Assemblies, Outer Can and Diffuser Components and Rear Bearing Support Spider

trated and the centring piston is stabilised due to flow through the jet (*e*), ports (*b*) and (*d*) being closed.

Starting and Acceleration.—The starting and accelerating system controls the fuel flow in the case of no load acceleration so that the turbine cannot be overheated. This is achieved by limiting the fuel pressure, hence the fuel flow is a function of the air pressure after the compressor.

The control consists of a casing in which three chambers (2, 3, 4) are each divided into upper and lower compartments (*u*, *l*) by flexible diaphragms. In chamber (3) the diaphragm is rigidly attached to the profile metering piston (16) in which a passage (17) is drilled. This piston prevents the fuel from flowing freely from inlet pipe (6) to outlet pipe (12). The drilling (17) communicates with compartment (3*u*) and air pressure after the compressor is exerted on the other face of the diaphragm. An externally adjustable bleed screw is also connected to this air chamber. A fuel transfer passage (9) connects the fuel inlet on one hand with the diaphragm of chamber (5) via the fuel transfer (8) and on the other hand with chamber (2*l*) via the fuel transfer (11). An externally adjustable spring maintains open the starting valve (18) which is rigid with its diaphragm. The short transfer piston (14) is rigid with the diaphragm of chamber (2). Depending on the extreme positions of this piston fuel can flow down the pistons to chamber (3*u*) or it can stop flow from pipe (9) and connect the chambers (3*u*) and (4*l*) with the spill pipe.

The electro-valve consists of a small battery operated solenoid and a casing in which the chamber (4) is divided into two compartments by a diaphragm. A fuel transfer pipe (12) connects the acceleration control fuel outlet with the upper compartment; the lower compartment communicates with the oil chamber (3*u*). The fuel outlet passage has a calibrated jet (20) from which fuel passes to the inlet tube in the compressor shaft. The diaphragm and the valve (21) are rigidly attached and the spring tends to keep the valve closed. A soft iron disc is secured to the other side of the diaphragm. As the solenoid is operated by the same switch as the ignition coil, the fuel can flow to the turbine only when lighting can occur. The working of this system is linked with that of the governor which features three phases.

Starting Phase.—On starting, the fuel and air pressure after the compressor being zero, the diaphragms of chambers (2) and (3) are fully deflected by the separating spring (13) and the profile fuel metering piston is so displaced from that shown that oil can only pass from (6) through the lower annular port to the starting valve (18). At this stage this valve is kept open by a spring and the fuel can flow only through pipes (8) and (10) round the upper annular port to pipe (12) and hence through the solenoid valve. Flow in the circuit (9) is prevented by the lower waist of the short piston (14) as fuel pressure is exerted on the diaphragm, which is fully deflected upwards. The solenoid opposes the closing spring of the valve (21) and fuel can be admitted to the engine. Meanwhile, as the compressor speed and hence the air pressure rises the diaphragm in chamber (3) is displaced upward, the metering piston thereby opening a direct passage between the two annular chambers and the solenoid chamber. As fuel pressure is also rising the starting valve closes and fuel has now access to the chamber (2*l*) via pipes (10), (9) and (11). During this transitory period, due to the joint influence of the spring (13) and the reduced oil pressure in the diaphragm of chamber (2), the short piston (14) descends so that pipe (9) communicates with the piston drilling and consequently the diaphragm in chamber (3) is now directly exposed to the fuel delivery pressure above as well as by the compressor pressure below. Its resultant deflection thus determines the position of the profile piston and the fuel then admitted to the engine can be restricted to correspond with the desired air/fuel ratio. Up to this stage and until the governed engine speed is reached, the governor circuit is isolated by the distributor piston, the governor centring piston and hence the metering piston remaining centralised. Consequently the engine is solely governed by the profiled piston of the accelerator control.

With the onset of the third phase, as governed speed is reached, the governor distributor piston tends to be displaced so that the port (*a*) communicates with (*b*) and the oil pressure is now communicated to the upper compartment of chamber (2) via the port (*f*) and orifice (1). Its diaphragm now displaces the short piston further downwards. This is its other extreme position. Pipe (9) is sealed and chambers (4*l*) and (3*u*) communicate with the spill pipe and are thereby relieved of the fuel oil pressure. The profile piston then rises to its fully opened position and thereafter the engine operates under the sole influence of the speed governor. Fuel pressure is sufficient to keep the solenoid valve open and the latter can be switched off.

The governor is normally set to maintain an engine speed of 25,000 r.p.m. Above this speed the movement of the throttle control progressively compresses the governor control spring through a linkage (not shown).

Combustion.—Fuel is admitted to the bore of the rotor shaft through an end cap incorporating a labyrinth seal, which can be seen in the sectional drawing. Within the bore a baffle plate dissipates the velocity head of the oil, which is distributed locally around the bore, the oil pressure after admission being only slightly above atmosphere. Because of this slight head the fuel inlet labyrinth communicates with a pressure air bleed from the compressor. Under these initial conditions and the centrifuge effect of the hollow shaft the oil progresses as a thick film along the bore to the injection wheel which is secured by studs to the flanges of the compressor shaft and rear cylinder of the drive shaft. Fuel is then accelerated during transit through radial passages in the wheel which are designed to impart suitable pressure and velocity heads for its discharge and distribution in the chamber.

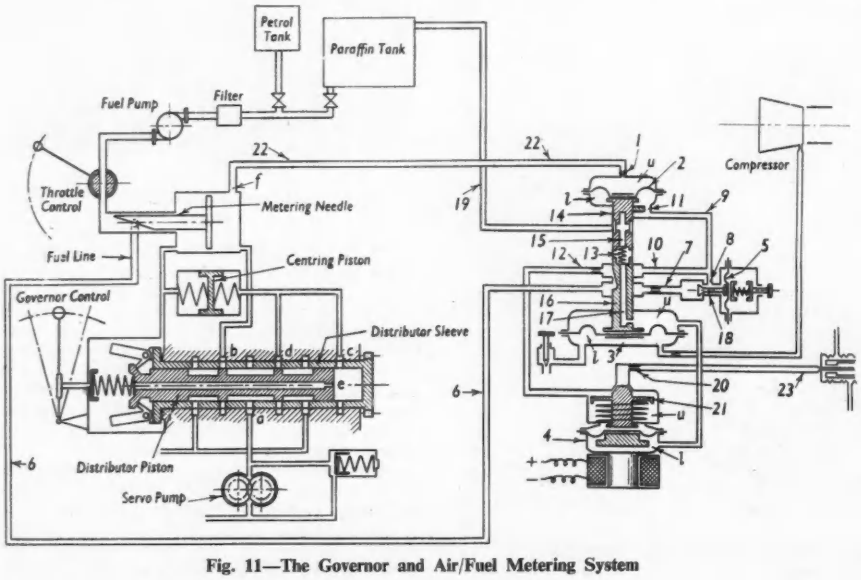


Fig. 11—The Governor and Air/Fuel Metering System

PRESENTATION TO MR. I. V. ROBINSON.—At a recent dinner in London, a presentation was made to Mr. I. V. Robinson, M.I.C.E., M.I.Mech.E., on the occasion of his retirement from his position as head of the steam turbine and allied plant sections of BEAMA. Mr. Robinson's service to these sections goes back over thirty-five years. The presentation took the form of an inscribed gold watch and an album containing the signatures of Mr. Robinson's many friends in the steam turbine industry. Mr. Robinson is continuing many of the other BEAMA activities with which he is associated. His work on steam turbine and allied plant is being taken over by Mr. G. T. H. Spurling, who became his chief assistant about a year ago.

SOME MODEL EXPERIMENTS ON SPECIAL CONTROL VALVES.—It has been pointed out to us that the advanced copies of this paper presented before the Institution of Mechanical Engineers on January 29th (from which we worked in preparing the abstract printed in our issues of February 5th and 12th) contained certain errors. On page 207 of our issue of February 5th, column three, the reference to the included angle of the spear should read 60 deg and not 30 deg. The drawing, Fig. 1, shows this angle correctly. On the same page curve *C* in Fig. 2 should return to curve *A* and not to curve *B* as shown. On pages 257 and 258 of the issue of February 12th the horizontal ordinates of Figs. 13 and 14 should read 0–4in and not 0–1in; and on the latter page the reference in the third column to Fig. 13 should be to Fig. 15.

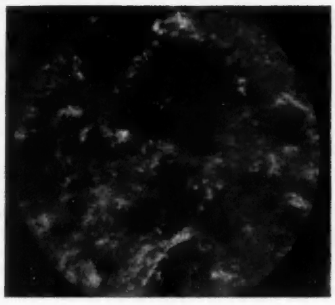
Improved Ceramic Insulating Material

A NEW ceramic insulating material for aero-engine sparking plugs, representing perhaps the largest advance in insulation development since before the war, has been put on a production footing by K.L.G. Sparking Plugs, Ltd. It has been named " Hylumina " and it is stated to overcome most, if not all, the difficulties which can arise with plug insulators at high boost and in engines with high operating temperatures.

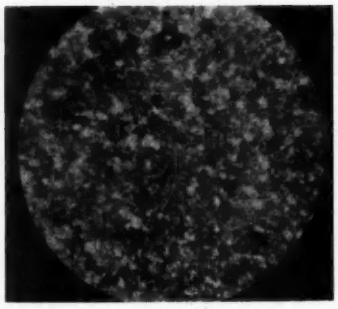
An efficient plug insulator must offer resistance to thermal shock, good heat conduction, poor electrical conduction, mechanical strength and resistance to tetra-ethyl-lead corrosion. It is worth briefly explaining these properties, in order to appreciate the complicated conditions under which a relatively simple component like a sparking plug has to work.

Thermal shock in aero-engine plugs occurring in each working stroke, causes cracking of the plug ceramic, usually at the part of the insulator, known as the nose, nearest to the combustion chamber. Good heat conduction is consequently required of an insulator in order to maintain as nearly as possible an even temperature throughout the length of the insulator. Its primary function is to offer the maximum resistance to the path of an electrical current, but, as will be seen, various factors can contribute towards the lowering of this desirable attribute.

When the plug is assembled the base of the insulator sits on a metal seat in the body of the plug and is clamped into position by a gland nut. Considerable force is exerted by this nut on the insulator, hence the necessity for a material with a high mechanical strength. In addition the insulators have to withstand the considerable effect of prolonged vibration.



(a) Old type ceramic



(b) " Hylumina " Section

Microscope Sections of Ceramic Insulating Materials at Magnification × 340

Tetra-ethyl-lead will form a lead oxide deposit on the insulator nose, which attacks the insulator and combines with one of its materials to form lead silicate. This forms as a glazed surface over the insulator nose, which besides being itself a relatively good conductor will form a gummy material which collects particles of carbon and dirt. This even further improves the chances of short-circuiting the plug. Both lead oxide and lead silicate are very difficult to remove once they have formed.

Before the war mica was extensively employed as a sparking plug insulator, but the introduction of lead impregnated petrol accelerated the search for a substitute insulating material.

This company produced a material, generally similar to an earlier German ceramic, which with later minor modifications was used throughout the war. It was composed of corundum, suitably bonded at high temperature.

This was more than adequate for the early wartime engines and for engines for some time ahead, but the limits of this material were seen soon after the start of hostilities and some experimenting began about 1941 to discover a more advanced material—which could be used on the big piston engines planned for the distant future.

Further developments followed using aluminium oxide, but fused pure alumina presented heavy production penalties in cost and time. By 1948 a material known then as " S.749 " was produced which appeared to have all the desirable qualities of pure alumina without its disadvantages. It was composed of about 95 per cent fine grained aluminium oxide, a bonding material and a little less than 3 per cent of silica acting as a flux for the other two. This material is compared with an earlier ceramic in our illustration. The advent of the gas turbine gave an added impetus to ceramic research and this new ceramic was submitted to the Bristol Aeroplane Company and Rolls-Royce, Ltd., for testing on their piston engines.

From these tests plugs with the following general characteristics were evolved for Bristol and Rolls-Royce engines : " Hylumina " insulators, a silver core fused to the platinum centre firing point, platinum alloy twin earth electrodes, a resistor of from 1000 to 3000 ohms, and a completely gas-tight joint between the insulators and the metal parts.

Slight modifications were required to the plugs designed for the Bristol engines to suit their special characteristics. They included the introduction of a bell-mouth end to the plug body to assist scavenging and to reduce the possibility of oiling. This ceramic has since been used on the larger gas turbines for igniter plugs and reheat plugs, the latter having to withstand temperatures of about 700 deg. Cent., and for jet pipe thermo-couples. Due to its hardness, " Hylumina " has also limited acceptance for tipping machine tools,

Manufacture.—In production the finely screened materials are compounded in mixers and slightly damped to give them a little cohesion. The mechanically mixed material is put into moulds and compressed roughly into shape. This cast is then formed into shape with a tipped tool and stacked in boxes for conveying to the furnace room. At this stage the insulators have to be handled carefully for they are still very soft.

In the furnace room the insulators are packed carefully in saggars, oblong boxes of fireproof clay. The saggars, mounted on trolleys, are coupled to a slowly moving conveyor through the furnace, which they transit in 26½ hours. During that time their temperature is slowly raised and for several hours they are exposed to a gas temperature of about 1600 deg. Cent. and then allowed to cool slowly.

Pairs of Insulators Being Dipped in Molten Tin. The Four-Arm Rig Automatically Moves the Insulators into Position and Dips them for the Correct Period

At the end of the firing the insulators have turned a pale blue colour. They are all checked optically for flaws and a sample batch from each firing is subjected to a thermal shock test and compressive tests to destruction.

Plugs are first coated with the dye Fuchsine. They are mounted, as shown in one of our illustrations, on a special rig and their noses dipped for several seconds in molten tin. Temperature of the tin is raised in 25 deg. Cent. steps from 600 deg. to 950 deg. Cent. If the insulator cracks the Fuchsine runs into the split and it becomes readily apparent.

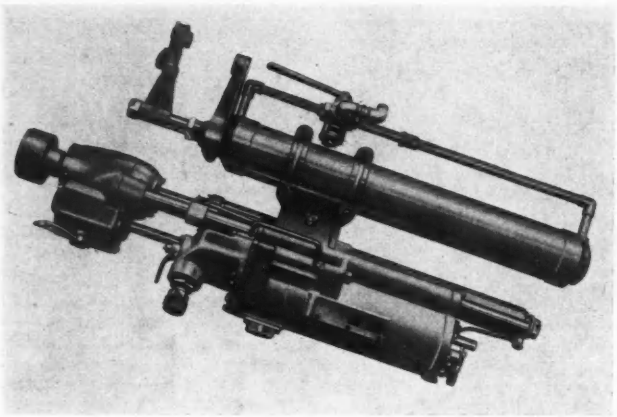
Next the widest point of the insulator is placed between the anvils of a compression testing machine and loaded until the ceramic breaks, the material always breaking along the major axis of the insulator.

BRITISH OCCUPATIONAL HYGIENE SOCIETY.—A conference on " Maximum Allowable Concentrations of Harmful Materials in Industrial Atmospheres " is to be held at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1, on April 6th, beginning at 11 a.m. It is being arranged by the British Occupational Hygiene Society, and the following papers are to be presented :—" The Investigation of Atmospheric Contaminants in Factories," by Dr. M. W. Goldblatt, head of Industrial Hygiene Laboratories, Imperial Chemical Industries, Ltd.; " The Measurement of Dust Exposure," by Dr. B. M. Wright, of the Pneumoconiosis Research Unit, Medical Research Council, and " Permissible Levels of Exposure to Ionising Radiations and Radio-Active Materials," by Dr. W. G. Marley, head of the Division of Health Physics at the Atomic Energy Research Establishment, Harwell. The conference fee for non-members of the Society is 12s. 6d. Further details and application forms may be obtained from Mr. P. C. G. Isaac, Public Health Engineering Laboratory, King's College, Newcastle upon Tyne, 1.

Demonstration of Pneumatic Tools

LAST week a demonstration of some of the latest designs of pneumatic tools and equipment made by Holman Bros., Ltd., Camborne, Cornwall, was given at the firm's Acton works. This works is used for the storage of spares and the servicing of Holman plant in the Home Counties. It is also responsible for the assembly and testing of certain of the plant made by the firm, in particular its "Tractairs" and "Holpacks," and for this work a large new extension to the factory was recently opened.

The "Tractair," it may be recalled, consists of a complete compressor assembly designed for attachment to a "Fordson" tractor; and the "Holpack" a compressor assembly for fitting to selected standard agricultural tractors.



Hydraulic Feed Diamond Drill Fitted with Rod Puller

These plants were shown in course of assembly and were used in some of the equipment demonstrations.

One recently introduced tool of interest which was demonstrated was the hydraulic feed diamond drill illustrated above. This drill is a lightweight portable machine suitable for blast hole or exploration work with diamond drills and is suitable for drilling 1½in diameter holes up to 500ft deep, using standard extension bits and equipment. Larger diameter holes can be drilled to shallower depths with the machine. The drill is built up from a number of units, each complete within itself and removable for servicing without interfering with the remainder of the assembly. It is designed for mounting on a standard rock drill saddle.

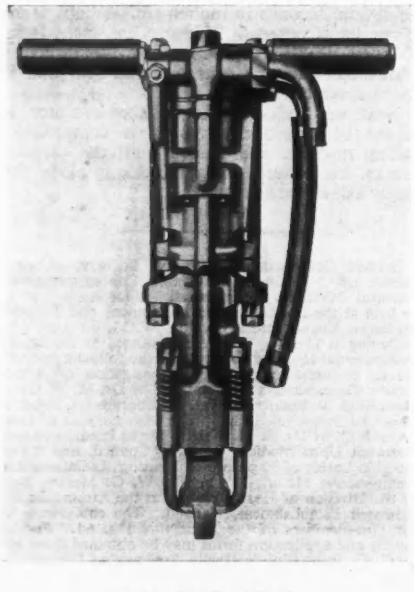
The 14 h.p. air motor of the machine drives a two-speed drill head gearbox, which can be supplied to give speeds of 800/1400 r.p.m., 800/1800 r.p.m., or 1400/2600 r.p.m. The air motor also drives the hydraulic pump for the feed ram, and the feed rate of the drill can be actuated through a control knob as required. Once the feed pressure is set at the required level it is automatically maintained, and is not affected by variations in the rate of penetration. Alternative feed lengths of 27½in or 30in are available on the machine. If required a rod puller such as that shown in the illustration can be supplied with the machine. Either a chuck and water swivel, or blast hole adaptor can be used. A built-in water swivel enables a fixed water connection to be attached to the rear of the machine for adaptor work.

A new medium lightweight hand drill known as the "Silver Three," and shown in our second illustration, was also demonstrated. This drill, which has a bore of 3in and a stroke of 1⅛in, weighs some 53 lb dry, and is designed for use with an airleg. It is designed to give light blows at very high speeds to make possible rapid penetration and prolong the insert life of a tungsten carbide tipped bit or steel.

The valve of the drill is enclosed in a chest at the rear end of the cylinder and, having a short travel, is not subject to wear on its periphery. Rotation during drilling is effected with a four-pawl twist bar and ratchet, the twist bar having six splines and the piston eight. The machine can be arranged for dry or wet drilling and it takes ⅞in and 1in hexagonal shanks.

In one of the rock drilling demonstrations the "Dryductor" introduced a few years ago was coupled to a drill, and the way in which it kept the surrounding atmosphere completely clear of rock dust was particularly noticeable when compared with a drill working without a "Dryductor." With this equipment all the dust and chippings created as a drill penetrates the rock are drawn back through the hollow drill steel and out through the rear of the machine, whence it is conveyed by a hose to a dust container. The dust is drawn back through the tool and hose by what is termed an "Eductor," which is essentially an ejector operated by compressed air taken from the inlet side of the air line lubricator.

Amongst the other tools shown in operation were an air-operated drilling machine, a pneumatic riveter, a grinder, a pneumatic chain saw and a pneumatic concrete compactor.



Lightweight Rock Drill

Three-Power Decisions on Atomic Energy Information

As a result of the recommendations made by the Sixth Tripartite Declassification Conference, held at Chalk River, Canada, in April, 1953, amendments have been made to the declassification guide which is used to decide what atomic energy information may be published and what must remain secret. The recommendations of the conference were made in the light of agreed basic assumptions about the objects of security policy and took account of developments in atomic energy projects outside the three participating countries. The present position is summarised here in the form of a statement issued by the Department of Atomic Energy.

Reactors.—As a result of previous declassification conferences, much of the design and operating data for low power research reactors have been declassified. At the 1953 conference, the principal subject for discussion was the possibility of extending declassification to power producing reactors. A major difficulty in formulating policy for power reactors is that no sharp dividing line can be drawn between such reactors and reactors for plutonium production or military purposes, and indeed designs have been discussed for dual-purpose reactors for producing power and plutonium. It was agreed that whilst information of critical importance for the design or operation of reactors for plutonium production or military purposes must still be kept secret, information required for studies of the economics of power reactors should as far as possible be released. As a start, a detailed examination was made at the conference of how such principles could be applied to natural uranium and slightly enriched uranium reactors, and a list has been agreed showing the kind of information which can safely be released. With this list as a guide each country will draw up detailed rules for each of its own reactors in this class, subject to the limitation that the information released will not exceed that permitted by the agreed list.

Industrial Processes and Production Technology.—Up to the present all work in production establishments, such as the Windscale and Capenhurst works, has been treated as classified. It has been agreed that many of the less important details and processes can now be released, whilst maintaining secret the production technology of substances of critical importance to the project. However, in the case of heavy water and graphite production and the reduction of uranium compounds to metal, it has been agreed that some of the older production processes can now be declassified.

Nuclear Physics.—All information on the neutron cross sections of carbon and graphite has been declassified. The spontaneous fission rate of plutonium 240 has been declassified. As a result of previous conferences, values for the thermal neutron cross sections of U235, U238, natural uranium and plutonium 239 were released. It has now been agreed that the cross sections may be published in the ordinary way together with experimental details of the method of measurement.

Chemistry and Metallurgy.—Much of the basic chemistry of plutonium has already been declassified. It has now been agreed that some of the physical properties that are related to the metallurgy of pure plutonium can also be released. Basic chemical studies involving the use of ion exchange resins for all elements except plutonium can be released, as can basic studies on the chemical kinetics of fluoride corrosion. Information can now be released on the production of fission products as sources of radiation for industrial and medical purposes.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

GUIDE TO THE SELECTION OF FITS

No. 1916, Part 2 : 1953. Price 7s. 6d. This guide to the selection of fits provides reliable data in the form of recommended tolerances which can be used for a variety of standard applications.

The introduction of a new limits and fits system is inevitably a long-term project and it is thought that many users, faced with the wide choice of fits in Part 1 of B.S. 1916, might consider that a long period of experiment was necessary before deciding which tolerances to adopt as standard. Reference to Part 2, with its selection of clearance, transition and interference fits for many typical applications, should go far to solve this problem as well as minimising the possibility of differing tolerances and allowances being chosen to meet the same design problem.

The guide is fully illustrated and includes much useful information regarding the various grades of fit, the accuracy which can reasonably be expected from various manufacturing processes, &c. It also contains tables of preferred fractional and decimal inch sizes, the use of which is indispensable to true standardisation.

The recommendations given in the guide are based on the results of investigations carried out with the co-operation of a number of engineering firms and organisations. It is recognised that some requirements are not yet adequately covered and an early revision of the guide to include more material is envisaged. In order that this work may be as practical and helpful as possible, users are requested to submit to the Institution comments, criticisms and constructive suggestions for consideration by the responsible committee. Any information supplied will be treated confidentially and will be of great assistance in rendering this guide of real value to industry.

Ultrasonic Flue Dust Elimination

By H. MANLEY, Ph.D., B.Sc.

Theory

It has been known for twenty years that relatively low frequency ultrasonic waves, say, not greater than 100 k/cs and usually down to 20 kc/s, will precipitate smokes such as sulphur trioxide, magnesium oxide and carbon black. Those particles of the order of 10 micron particle size will be quickly coagulated into aggregates in the presence of an ultrasonic beam, and fall out of suspension. For smokes of commercial and industrial interest it is found that there is an optimum frequency for the coagulation of any particular smoke. It seems probable, also, that there is an optimum amplitude or intensity of ultrasonic vibration for efficient precipitation, but less work has been done on this aspect. Theoretically, the intensity required for precipitation should increase as the square of the particle density. Usually, it is assumed that the coagulation occurs at the nodes of the ultrasonic

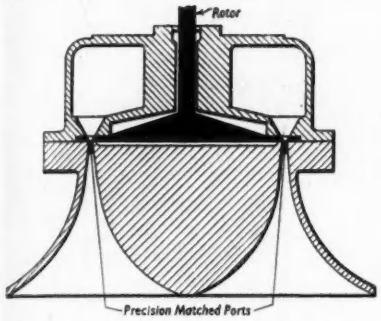


Fig. 1—Cross Section of Sonic Generator

waves, by the small particles hitting each other under the beam's influence. This idea will explain why the efficiency of precipitation will vary with the ultrasonic frequency and intensity. The small particles will only coalesce if they hit each other with a minimum velocity—otherwise they will merely bounce away. The velocity the small particles obtain will clearly depend on the force exerted on them which is accelerating them.

Practical

While the ultrasonic research men, such as Bergmann, Wood, Richardson, have known the practical possibilities of their academic work in the laboratories, the trouble has been to develop a sufficiently powerful ultrasonic generator for large-scale commercial use.

Currently the usual methods of ultrasonic generation are electronic, via magneto-striction and piezo-electric oscillators. It has proved difficult to make generators with more than about 10W output. This small power output will, in general, be insufficient except for pilot plant operations. For this reason applications of ultrasonics have been kept back to laboratory tricks, &c.—only recently reaching commercial applications, such as aluminium soldering irons.

If, however, one reverts to a more ancient and, indeed, the classical mode of ultrasonic generation, the siren, very much higher powers become immediately possible, in the form of commercially available equipment. Up to 300W sources can be bought from manufacturers for operation from 500 c/s up to 20/50 kc/s, i.e. in the lower end of the ultrasonic spectral range (Figs. 1 and 2). This output will give an intensity level of 150/165 decibels. The power given by such sirens will fall as the frequency at which it is operated increases. Thus equipment giving 300W at 5 kc/s will fall off in power output to perhaps 200W at 20 kc/s.

The Siren as a Generator

Single siren type generators exist which yield 10kW and will treat 50,000 cubic feet of gas per minute. For sulphuric acid mist, or cement dust recovery the usual operational technique is to put the ultrasonic generator into the gas stream before it reaches a "cyclone" precipitator. In this way the very small particles are agglomerated for easy removal by the centrifugal blower, along with any pre-existing particles.

In certain cases it is claimed that particles as small as 0·01 micron can be precipitated, independent of gas temperature, up to 500 deg. Cent.

It is believed that the Ultrasonic Corporation of Massachussetts is the only commercial manufacturer of ultrasonic dust eliminators. This result seems to come from their use of a siren to get high intensity and power levels. Many commercial electronic and other firms in several countries have tackled some of the problems, but without completing an equipment of practical use in large-scale production plant. For this reason most of the data given herein refer to various equipments installed in American plant. There would seem to be no reason why similar plant could not be made in England if sufficient demand existed ; a round figure for a complete installation would seem to be £1000 or a little more, depending on the detailed circumstances.

It has already been stated that the efficiency of operation will depend on the frequency and amplitude employed. In use the frequency of ultrasonic waves formed is governed by the generator frequency, which can be controlled through a rheostat or similar device. The amplitude of the waves at the source will be governed by the pressure at which air is forced through the siren holes. The rotor may take up to 3 h.p. to drive it at, say, 20 kc/s, and a further 10 h.p. will be used for the compressor forcing air through the siren. These figures should enable operating costs to be estimated.

There are, of course, controlling factors in efficient smoke precipitation other than the frequency and intensity of the source. They include exposure time for the gas passing the generator, and the smoke load of the gas. These two latter factors are significant in so far as coagulation of the aerosol is concerned if the smoke is not very dense, because few particles will be available per unit volume to hit each other and coalesce under the ultrasonic bombardment. A typical minimum for economic use will be one grain of smoke per cubic foot, for 1–10 micron particle size. On the other hand, if the smoke is very thick, say, greater than 100 grains per cubic foot, a large attenuation of the ultrasonic beam may occur. In such a case it may be preferable to dilute the gas with air.

A typical exposure/load-density chart (for sulphuric acid mist as formed in the contact process) is shown in Fig. 3. The usual efficiency

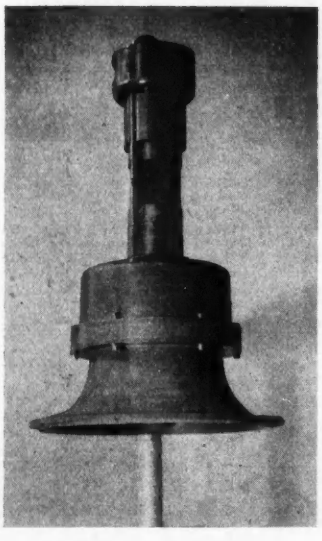


Fig. 2—Typical Ultrasonic Generator

aimed at is 90 per cent precipitation. The law of diminishing returns, economically speaking, operates if more than 95 per cent smoke elimination is demanded in the aerosol. A frequency of 5 kc/s will be the optimum for arsenical and ammonium chloride fumes, and a slightly higher one for tobacco smoke.

An independent firm, G. B. Brass and Aluminium, Inc., Los Angeles, has also made a siren, similar in general to that of the Ultrasonic Corporation, although somewhat different in detailed design, and intended for the higher frequency range. The G.B. siren is made entirely of manganese bronze castings except for the steel shaft,[3] operating on 5 lb to 10 lb per square inch air pressure at speeds in the region of 20 kc/s to 22 kc/s. This particular application of ultrasonic flue dust

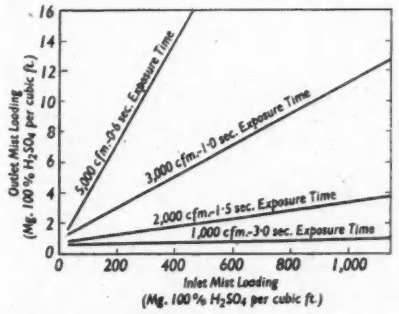


Fig. 3—Typical Chart for Sulphuric Acid Precipitation

suppression, for brass and aluminium foundry fumes and smokes, seems to have been not altogether successful, but it is interesting to note that it was estimated that a firm wishing to make such sirens for their own use or experimentation could do so for about £330 (1951 figure).

Ultrasonic smog and dust suppression devices of the type herein described have been installed in many firms. They include brass, aluminium foundry smoke, soda ash fumes, sulphuric acid mist, cement flue dust, carbon black fumes, zinc fumes and oil mists.

Perhaps, in conclusion, one may offer a mild apology for having used the term ultrasonic precipitator when a quite audible sound frequency of about 5 kc/s is often the optimum one. The technique has developed from experiments and theory in ultrasonics proper (i.e. sound at a frequency above 20 kc/s). Few people can hear above 14 kc/s and even at present the equipment mentioned is often used at 20 kc/s and a little above. Also the future development of the method will probably lie in the higher and higher frequency range as the practical problems of siren and oscillator design are overcome, at commercial power levels. The frequency of operation can also be expected to rise if the conditions of operation become more stringent ; thus, if a 100 per cent removal of dust is essential and/or very light and small particles have to be eliminated. This fact can be appreciated if one merely considers the natural rate of fall of particles of density 2 in air. At 9 micron diameter their rate of fall is 0·425cm per second, at 6 microns it is 0·22cm per second, and at 2 microns it is 0·03cm per second. The carbon black industry is one likely to be interested in particle sizes well below 2 microns ; at present it is satisfied with only a little over 80 per cent recovery.

Finally, it might be said that the reversion from modern techniques to more classical ones, in search of high power may, in the view of some experts, even go completely back to the Galton whistle, with air, steam or waste flue gas to drive it. If this becomes practicable a wide frequency and intensity range at very low cost should become available.

References

[1] H. Manley : *Discovery*, 215 (7), 1948.
[2] Brand, Freund, *et alia* : *Trans. Faraday Scty.* (32), 1936, 1101/5, 1125.
[3] T. A. Dickinson : *Foundry*, 224 (4), 1951.
[4] V. H. Gottschalk, H. W. St. Clair : *Mining and Metallurgy*, 244 (5), 1937.
[5] H. W. St. Clair : *U.S. Bur. Mines, Rep. Investign.*, 3400, 1938
[6] H. W. Danser : *Am. Inst. Chem. Engrs.*, 158 (5), 1950.
[7] H. W. St. Clair : *Rev. Sci. Instrs.*, 250 (5), 1941.
[8] B.P.: 454,050.
[9] C. A. Stokes, *Chem. Eng. Prog.*, 423 (8), 1950.
[10] C. R. Soderbury, Jnr., *Iron and Steel Engr.*, 87 (11) 1952.

Two Special Machine Tools

THE photograph we reproduce below shows a special machine built by Harry F. Atkins (Machine Tools), Ltd., Yaxley Sidings, Peterborough, for automatically contour milling an internal profile in a stainless steel aero-engine component. This component is 23in in diameter and the profile comprises a number of equally spaced legs of similar shape.

In this machine the cutter centre line is fixed

Automatic Contour Milling Machine

and the work is mounted on a large face plate. This face plate as it rotates rises and falls by gravity on a cam to impart the required profile of the legs. Since the form to be milled on the component is symmetrical, a fairly simple cam is required and it makes one revolution for each part of the form.

The cutter spindle is driven by an electric motor through a worm and worm wheel reduction and change gears arranged to give geometrically progressive speeds. The spindle runs in large split taper phosphor-bronze bearings, its thrust being taken by ball thrust bearings. The spindle complete with its drive is mounted on two vee slides to provide a means of adjustng the cutter horizontally and vertically in respect to the work. These adjustments are made by handwheels graduated to read in thousandths of an inch, and when the cutter has been set the slides can be firmly clamped in position.

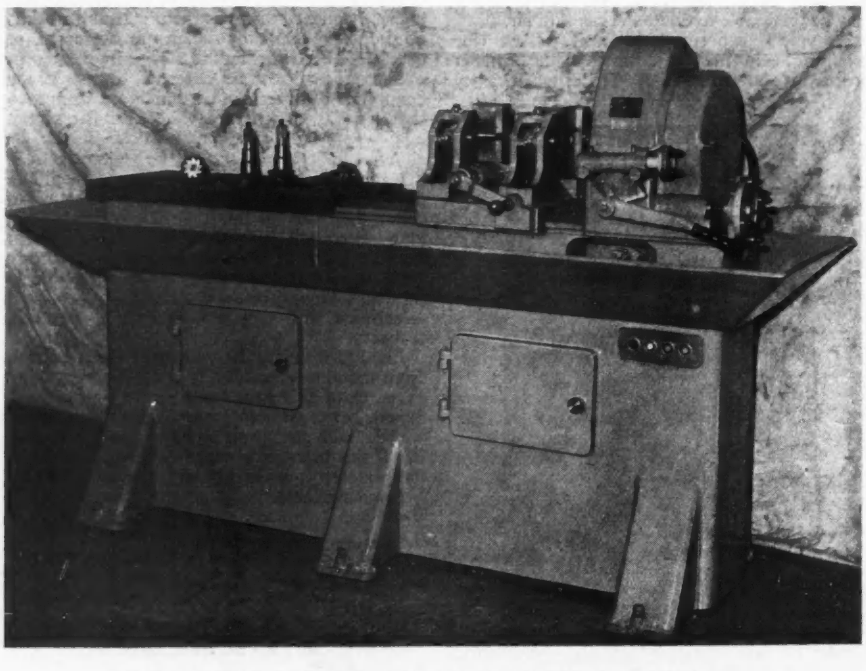
The workhead is bolted to the bed of the machine and has two vertical veeways on which the rising and falling face plate is carried. Drive from a motor in the base of the machine is transmitted by belts to two cone pulleys and six speeds are available. The cam behind the face plate is driven through spur and worm gearing from the main shaft. From this shaft two gearboxes at the back of the machine transmit the drive to the worm shaft of the face plate drive.

When the work supporting jig, shown in the illustration, is removed the cam is exposed and can be removed by the loosening of a single screw. Whilst the machine is in operation the swarf falls down an inclined chute into a removable settling tank, whence the cutting fluid flows back into the base of the machine ready for recirculation.

Recently the firm supplied an interesting adaptation of its centre-hole generating grinding machine for grinding, true to the teeth, the centre hole in the hypoid spiral bevel pinion for a motor-car. This type of Atkins machine has the spindle quill mounted on an inclined slide in a rotating housing so that as the spindle is withdrawn from the work it assumes increasing eccentricity in its housing, thereby generating a conical hole irrespective of the shape of the wheel. The end of the hole can be faced at the same setting and parallel holes ground as well.

The rig developed for supporting the work during grinding the centre hole in the motor-car bevel pinions can be seen in the illustration below. In it three standard balls are positioned axially by a flat hardened face and diametrically in a hardened bush. The balls are loosely held in a spider-like cage to prevent them falling too far out of position when the component is removed.

In operation a spring-loaded poppet centre for the far end of the pinion is moved back and the component is threaded into the ball cage until it rests securely in the balls and the poppet centre is then brought forward. To keep dust away from the balls a spring-loaded dust cover butts up to the end of the component. The ball locating member and the centre member are mounted on separate slides and each is adjustable by micrometer screws horizontally and vertically so that they may be set central with the wheel head.

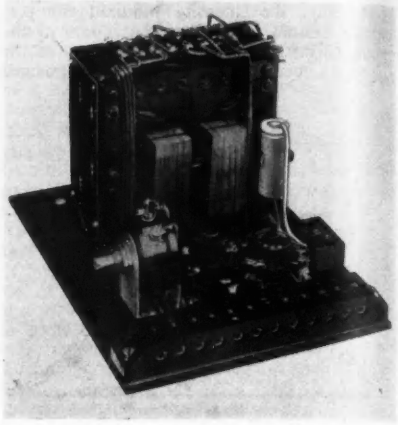


Adaptation of Centre-Hole Generating Grinding Machine for Bevel Pinions

Magnetic Amplifier for Educational Use

THE magnetic amplifier illustrated here has been developed by Electro Methods, Ltd., Stevenage, Herts, for instructional and experimental purposes. The design and construction are such that the principles of operation can readily be investigated. All the important measuring points are easily accessible and the circuit can be traced by following the colour coded connections.

The magnetic amplifier consists of a transformer-like structure comprising two magnetic cores of high permeability nickel alloy so designed that a close approximation to a toroid is achieved. Each core carries two a.c. windings in series, the windings being connected so that the relative polarity of the fluxes in the two cores is opposite. The two cores are embraced by common windings which are referred to as d.c. windings. Since these windings embrace the two cores in which



Single-Stage Magnetic Amplifier for Educational and Experimental Purposes

the polarity and magnitude of fluxes is exactly opposite, there are no voltages of fundamental frequency induced in them.

The magnetic amplifier is provided with positive feedback, the value of ampere turns being 100 per cent with an additional 5 per cent which may be connected additively or subtractively as desired, thus giving 95 per cent to 105 per cent feedback. A smooth control of self-excitation may be obtained between these limits by connecting a variable shunting resistor in parallel with the 5 per cent winding. A larger control of feedback ampere turns may be obtained by connecting the shunt across the 100 per cent winding, but this is not generally done, since the study of the effect of feedback is more interesting when around 100 per cent.

The bias may be varied by adjustment of the bias potentiometer, the current being provided by a small rectifier connected across the supply. A 25μF condenser is connected across the bias rectifier to prevent rectification of the induced harmonic currents circulating in the bias winding. The bias current can be measured by connecting a 20mA instrument to the terminal block ; for normal working this terminal block is bridged by a short circuiting link. Briefly, the amplifier specification is as follows : supply voltage, 20V at 50 c/s ; input resistance consists of two independent windings of 100 ohms each, which may be connected in series or parallel or used independently ; recommended load, not lower than 30 ohm ; output power, 2·7W in 30 ohm load ; power amplification, 40,000 with 100 per cent self-excitation in 30 ohm load.

ALUMINIUM ALLOY STRUCTURAL SECTIONS.—The Aluminium Development Association, 33, Grosvenor Street, London, W.1, has published an addendum to its "Applications Brochure No. 6," which was entitled "The Use of Aluminium Alloys in Structural Engineering." The issue of the addendum, "Bulbed and Lipped Structural Aluminium Alloy Sections" (angles and channels) is due to the availability of new shapes designed to overcome difficulties in using thin sections. The publication contains design notes, together with data concerning the new sections, the properties of which are set out in tabular form similar to that given in B.S. 1161.

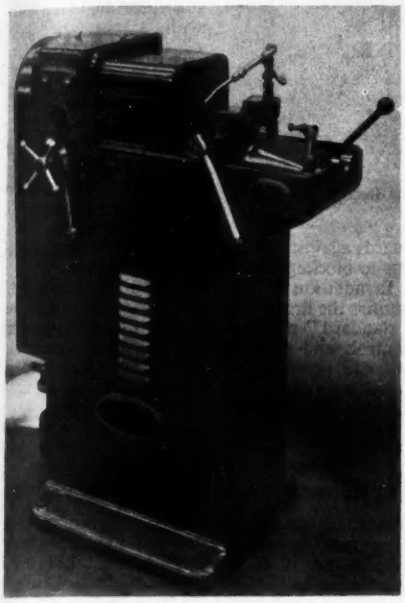
Threading Machine for Small Components

A THREADING machine for small-diameter components recently added to the range of equipment made by Alfred Herbert, Ltd., Coventry, is illustrated on this page. It is designed for use with rotary "Coventry" or "Landis/Lanco" dieheads and the threading of pipes up to ¾in diameter or such things as bolts up to ¾in diameter for maximum lengths of 3in.

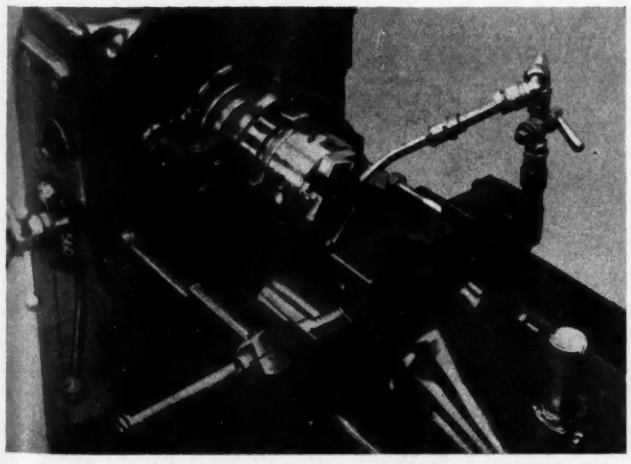
The hollow spindle is mounted on preloaded anti-friction bearings and adapters can be fitted to accommodate the different kinds of dieheads. These adapters are so designed that any swarf which passes to the back of the diehead is flushed away to the swarf basket in the sump of the machine, and coolant leakage through the spindle is avoided. A four-speed motor drives the spindle through a vee belt and the four reversible spindle speeds available are 260, 420, 560 and 840 r.p.m. The spindle speed is selected by setting a star wheel on the front of the machine, and a reversing lever is placed behind the speed selector dial. If required, different belt pulleys can be fitted to change the range of spindle speeds.

The work carriage is mounted on two ground steel bars and it is moved backwards and forwards by an adjustable hand lever through an arrangement of links. The work vice shown fitted to the machine in the illustrations can be removed and replaced by a special work fixture or a power-operated vice, if required. An adjustable work stop and support is provided on the carriage, and there is a depth stop which can be used for small workpieces.

Diehead opening and closing is effected by carriage movement, and for this purpose an adjustable screwed rod is fitted to the carriage face to actuate the diehead yoke operating mechanism. A motor-driven pump in the base of the machine provides an adequate supply of coolant, and a hinged shield over the head protects the operator from splashes during the screwing operation.



Threading Machine for Small Components



Machine Fitted with "Landis/Lanco" Diehead and Hand-Operated Adjustable Vice

Hand-Operated Starters for Fractional Horsepower Motors

A SMALL push-button starter is being manufactured by J. A. Crabtree and Co., Ltd., Wallsall, for use with fractional horsepower motors operating under conditions which do not call for remote control or low-voltage protection.

The "D–6" starter is made in three forms, two of which are illustrated here. The first form (Fig. 1) consists of a switch assembly which can be mounted in the casing of the driven machine so that only the push-button shroud emerges through a suitable hole in the machine casing. In the second form (Fig. 2) the switch is arranged as a complete unit suitable for flush mounting; the switch body is recessed into the frame of the controlled machine and is then covered with a front plate fixed by four corner screws. The joint between the button shroud and the plate is waterproof and oilproof. In the third form (not illustrated here) the switch is completely enclosed in a smooth finished casing suitable for external mounting on the controlled machine. The button shroud is the only part projecting through the front cover and again the joint is waterproof and oilproof. The case measures 3 11/16in by 4 11/16in by 3 1/16in overall.

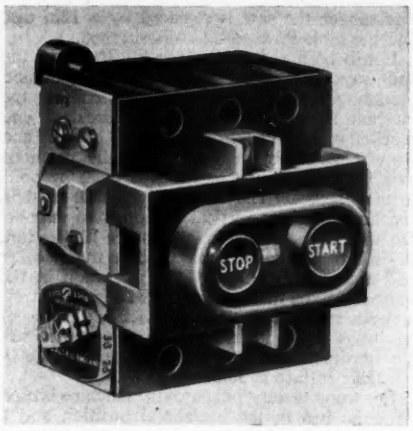


Fig. 1—"Interior Unit" Starter for Inset Mounting in Machine Cases or Control Panels

In all three forms of the control unit the switch itself is the same. It consists essentially of a rectangular moulding which is recessed to house a triple-pole switch in the front and three thermal overload relays in the back. The moulding incorporates barriers which provide phase separation for the switch and the thermal overload elements. Adjustment of the overload setting to the line current of the motor is made through a pointer (on the left of Fig. 1), which can be moved with the blade of a screwdriver. Ambient compensation is provided, to enable the starter to work satisfactorily over a considerable range of room temperatures. The starter has an inherent "free handle" release which is reset by operating the "stop" push button after the overload relay has returned to the normal position; accordingly, an overloaded motor is disconnected from the supply even if the operator keeps the "start" button depressed. Full positive drive is transmitted to the switch from both push buttons. Deliberate finger pressure is required to start the motor, but, in the running position, the "stop" button projects beyond the shroud and can be operated by a manual blow in an emergency.

The starter is suitable for single-phase or three-phase a.c. supplies up to 600V, with current ratings ranging from 0·2/0·3A to 3·8/6A.

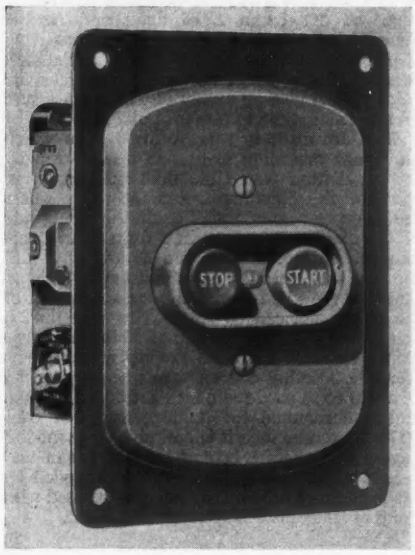
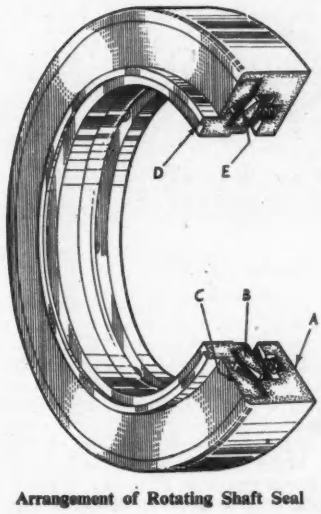


Fig. 2—Starter Arranged for Flush Mounting

Rotating Shaft Seals

A NEW mechanical face seal for shafts rotating at high speeds is now being made under the trade name "Impax" by Charles Weston and Co., Ltd., of Douglas Green, Pendleton, Salford, 6. The general arrangement of one of these seals, which are made in a range of sizes for shafts from ¼in to 7¼in diameter, can be seen in the diagram we reproduce on this page.

The body *A* of the seal and the guide rings *B* and *C* are machined all over and, according to requirements, can be made of bronze, steel or light alloy. Fluid is sealed in the bearing chamber by the contact of the nose of a special bronze or carbon ring *D* with a true running flat face. This face is hardened, ground and lapped, and may be on the inner race of a ball or



Arrangement of Rotating Shaft Seal

roller bearing or machined on a separate contact ring. A diaphragm *E* of fluidproof, flexible material is hermetically sealed to the nose ring at its inner diameter and to the body of the seal. A series of coil springs between the body and the guide ring *B* give an evenly distributed pressure on the sealing nose to prevent leakage.

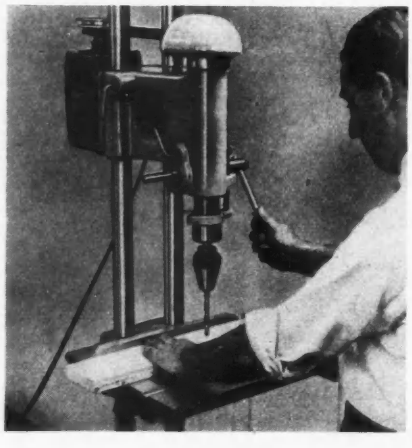
Seals are made in three forms, two of which are flange mounting seals, one being normally for installation where the fluid pressure is in front of the diaphragm, and the other where the fluid pressure is behind or on the spring side of the diaphragm. The third form is an interference fitting seal which can be arranged with the fluid either in front or behind the diaphragm. Standard seals with the fluid pressure in front of the diaphragm can be supplied to withstand a continuous working pressure of 50 lb per square inch. In these seals the sealing nose retracts from the rotating contact face when a pressure of about 65 lb per square inch is reached. When seals are required for fluid pressures of over 50 lb per square inch it is desirable to fit models having the pressure behind the diaphragm and special design arrangements can be supplied by the makers. The standard seals can be used with fluids at temperatures up to 130 deg. Cent.

Multi-Purpose Machine

A VERSATILE machine which can be converted into a disc sander, a vertical or horizontal drilling machine, a circular saw or a wood turning lathe, is now being made by Smart and Brown (Machine Tools), Ltd., 25, Manchester Square, London, W.1.

As shown in the illustrations of the machine on this page, it has a tubular steel stand with brackets at each end supporting two precision ground round bar ways for the table, headstock, &c. The headstock is driven by ½ h.p., 1440 r.p.m. motor through interchangeable three-step cone pulleys giving a range of six spindle speeds from 600 r.p.m. to 3400 r.p.m. The driving pulley is mounted on a sleeve and drives the spindle through four splines. The quill of the headstock has a traverse of 4in and it can be locked in any position to suit the attachment being used. A No. 6 Jacobs taper in the spindle nose accommodates the various attachments, which are locked by means of a screw. The headstock, table, tailstock and a hand tool rest for turning can be moved freely along the bed ways and locked in position by pad bolts.

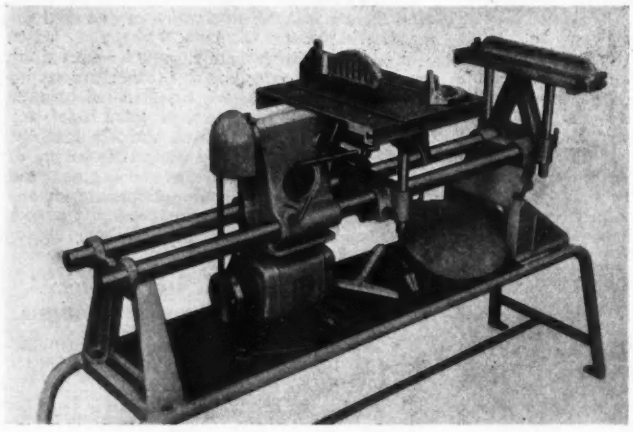
A tilting table of cast aluminium alloy, which is adjustable for height in its carriage, is tee-slotted across its top and along its two sides. This



Machine Arranged as a Vertical Drill

table has a 17in by 14½in working surface and can be tilted 90 deg. in one direction and 45 deg. in the other.

When the machine is used as a woodworker's circular saw, as illustrated, it takes an 8in diameter saw suitable for cutting to depths up to 2⅜in. A saw fence and, when required, a mitre gauge can be clamped by the table tee slots. When it is required to cut long lengths of material an extension table can be fitted on the tailstock unit to provide adequate support at the free end. To convert the machine into a disc sander the saw is replaced by a 12in disc and the table lowered and repositioned.



Machine Arranged as a Woodworker's Saw Bench

It will be noted that at the tailstock end the bed ways bracket is supported in a trunnion mounting on the base frame. To convert the machine for vertical drilling the headstock end bracket is unlocked from the base bracket and the whole assembly is swung up on the trunnions to a vertical position and locked there by bolts in the bracket. The table can then be used in the horizontal or vertical positions to support the work, as shown in the other illustration. A ½in capacity drill chuck is used on the machine and the quill is unlocked for operation in the normal way by means of a handle and fitted with a depth stop. With the headstock at the top of the ways and the table in its lowest position the maximum distance from the drill chuck to the table surface is 30in.

For wood turning purposes the machine is used with the bed in the horizontal position and a hand tool rest is mounted on the ways in place of the table unit. Work up to 15in diameter and 32in long can be swung on the lathe.

Turbine Lubricating Oil Purifier

THE accompanying illustration shows one of a new range of turbine lubricating oil purifiers which are made by Sharples Centrifuges, Ltd., of Woodchester, Stroud, Glos, and are particularly intended for use in power stations where a neat appearance is desired, to conform with the surroundings. In these purifiers all the controls and instruments are grouped on a flush-mounted panel and a high standard of finish is applied throughout.

The purifier can be supplied with a feed or a discharge pump depending on whether the feed to, or the return from, the machine is by gravity. When required in special cases both feed and delivery pumps can be fitted. The gear pumps used are driven directly by the centrifuge motor through a speed reducer. The pipe connections can be varied to suit operating requirements, and provision is made whereby the electric oil heater can be by-passed without stopping the machine, and removed for cleaning or inspection.

The elements of the electric heater are arranged to give the maximum thermal circulation in the water bath and ensure high overall heat transfer. Circulation of the oil and water in the heater are counter-current, and the water bath does not require a constant flow of water through it. An advantage of a water bath of this kind is that it can be filled with condensate or treated water, and scaling of the heater tubes, as might happen with a constant flow of untreated water, is avoided. The rate of oil flow maintained in the heater coils is sufficient to avoid deposition of sludge. The oil circulation system is fitted with temperature and pressure gauges, and a pressure-relief valve guards against possible build up of back pressure due to blockage of the downstream line.

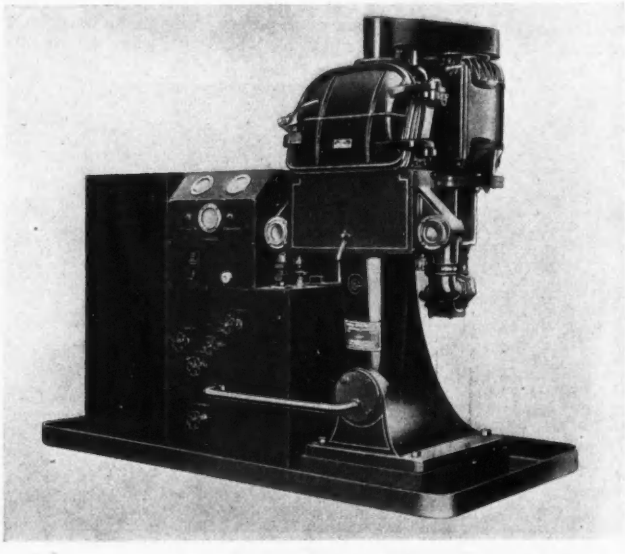
In addition to this highly finished design of purifier the firm is also making what is called the "standard" model purifier in which the heater controls and motor starter are panel mounted, but the pressure gauge, oil thermometer and valves are mounted directly on the pipework, and the standard of finish is not so high.

Dual-Current Rectifier for Welding

A DUAL-CURRENT rectifier, designed to give an output, for welding, of 40–240A alternating current or 10–80A direct current, has been introduced by Philips Electrical, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. As illustrated opposite, the rectifier is enclosed in a ventilated drip-proof case 22in by 24in by 34in high. The equipment is designated "1308/2" and is suitable for connection to a three-phase, 380–440V, 50 c/s supply, but it can, alternatively, be supplied in a form suitable for two-phase, 200–220V, 50 c/s systems.

In both the a.c. and d.c. ranges, the output is smoothly variable by means of a magnetic shunt and a calibrated scale is fitted to indicate the welding current on either of the two ranges. The choice of current is made by the use of a change-over switch; all connections required for the transition between d.c. and a.c. are effected by this switch. The switch is three positional, the centre position interrupting the welding current.

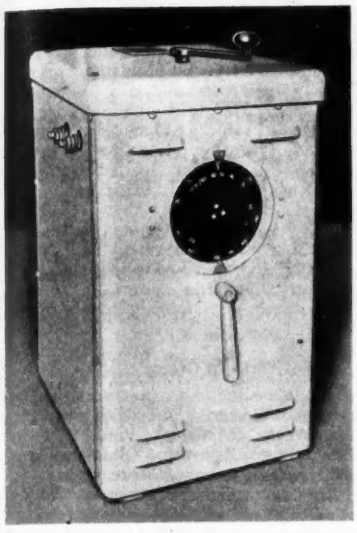
When the set is switched for d.c. operation



Turbine Lubricating Oil Purifier

the primary windings are Scott connected ; for a.c. working the windings are connected in parallel. The secondary windings are so arranged that, when they are on d.c. operation with the Scott circuit, the windings supplying each separate rectifier valve are 90 deg. phase-shifted with respect to each other. For a.c. operation the four sections of the secondary windings are connected in parallel and the rectifier valves are removed from the welding circuits.

When direct current is required, the transformer output is fed to two rectifier valves (type "1054") which are protected from premature



Dual-Current Valve-Operated Rectifier

loading by a time-delay valve (type "4152") and from excessive current input by a microswitch device operated directly from the shunt mechanism.

The time delay valve ensures that no welding current is supplied to the rectifier valves before the valve filaments have reached operating temperature, (too early tapping of current would be detrimental to the long life of the valves). The delay of the tube is about sixty seconds and when this time has elapsed the bi-metal relay closes and operates an automatic switch releasing the welding current to the valves. Since the electrical inertia of the set is low, the response is very rapid and oscillograms show that an interval of about 0·002 second only is required for arc recovery.

All the valves are spring mounted and, to simplify maintenance, the valves, change-over switch and time delay mechanism are all readily accessible from one side of the equipment.

Capacitors are available for improving the power factor of the rectifier ; they are arranged in the form of a separate assembly containing two capacitors, each with a rating of 3kVA.

Canadian Building Research Centre

A BUILDING RESEARCH CENTRE for the Division of Building Research of the National Research Council of Canada has recently been erected at Ottawa. Office and laboratory accommodation of various kinds (the Division has much office work for the Canadian Government Specifications Board and the National Building Code) is provided by a building of a million cubic feet capacity, arranged in T-shaped plan with offices and so on "crossing" the T, and the various laboratories in the stem.

In planning the laboratory facilities the Division had no precedent to follow, the Centre being, it was believed, the first building ever to be built to serve the needs of building research in general. The dimensions of the main working area were determined by the size required to accommodate an average two-storey house, which may be erected under the crane hook for structural and other testing. This area does not yet contain a large testing machine, since the exact needs for it have yet to be determined. Alternatively, steel beams have been embedded in the floor so that specimens can be securely anchored for testing with the crane, which has been designed for this purpose.

Much of the laboratory work of the Division must be conducted under controlled atmospheric conditions. The building itself is not fully air conditioned, but the site plan of the building provided a basement with practically no windows, thus making the conditioning of individual laboratories in this area a relatively easy matter. Two large cold rooms will be in operation by early spring. They will provide a laboratory for heating and insulation studies and a separate snow and ice research laboratory, which can be cooled to −50 deg. Fah. and maintained at that temperature, if desired.

African Engineering News

(By Our South African Correspondent)

Project for the Production of Dissolving Pulp

A £6,000,000 project, launched by the Industrial Development Corporation of South Africa, Ltd., Courtaulds, Ltd., of Britain and the Snia Viscosa Corporation of Italy, will produce dissolving pulp from the Eucalyptus Seligna timber grown in Zululand. This pulp is used in the manufacture of rayon. A factory is being erected at Umkomaas, on the Natal South Coast, for the parent company, South African Industrial Cellulose Corporation (Pty.), Ltd. The possibilities of seligna timber were realised some three years ago when a consignment was sent to the Snia Viscosa Corporation for tests. Production of pulp at the Umkomaas factory is expected to begin in 1955. Most of the machinery is being manufactured by an engineering subsidiary of Snia Viscosa, and it is estimated that initial production will be 40,000 tons of wood pulp, of which Italy and Britain would take 50 per cent each.

Refined Cadmium Production in Northern Rhodesia

New plant being erected at Broken Hill by the Rhodesian Broken Hill Development Company, will make possible the production of refined cadmium in Northern Rhodesia. This metal is precipitated at the mine from a zinc solution. Refined cadmium is produced in two ways : by electrolysis or distillation. At Broken Hill, the distillation process will be employed.

South African Railways

During the latter part of 1953, twenty-five main line steam locomotives of "13" class, nine steam shunting locomotives of "52" class, and two class "E4" electric locomotives, eight new passenger saloons and 415 goods wagons of various descriptions were placed in service by the South African Railways. Of the latter, sixty-three were built in the Administration's workshops, 183 by a Rand firm and 169 were imported from overseas.

In order to encourage and assist in the export of coal the Railway Administration brought a new system into operation on October 19th last. Coal is now being moved to the port of Lourenço Marques in block loads, each train consisting of nineteen bogies and carrying 780 tons net. Supplies were also worked back from Lourenço Marques in block loads. During the first week of the new scheme, six trains carried 4519 tons of coal (net) from the Transvaal to Lourenço Marques.

Expansion of Union's Uranium Output

It has lately been announced that further extensions to the Union's uranium production programme are to be made. The Randfontein Estates Gold Mining Company, Witwatersrand, Ltd., is to expand its uranium plant, and Dominion Reefs (Klerksdorp), Ltd., has also been invited to become a producer. The Atomic Energy Board has approved the expansion which will enable the Randfontein Estates to handle larger quantities of slimes which will arise from the treatment of additional tonnages of ore from the Bird Reef Series, which underlie the company's property. A circular to shareholders states that it is considered that the production of uranium oxide at the mine will commence early next year and that the expanded plant will be ready for operation about the middle of 1955. The total cost of the uranium project as well as the associated sulphuric acid production schemes as now envisaged is estimated to be £6,541,000, and this will be financed by means of loans. The borrowing powers of the directors are limited to the amount of the issued capital of the company for the time being, which is at present £4,063,353, and it will therefore be necessary to increase the borrowing powers of the directors in order to make arrangements for the granting of the further loan facilities required. It is proposed that the present issued capital be doubled. In a circular to members issued on April 8, 1953, mention was made of the fact that the Minister of Mines had granted written authority for an investigation to be made into the occurrence of uranium on the company's property. Since the authority was granted a comprehensive examination has been in progress, and, as a result, the company has been invited to become a uranium producer.

Arrangements have been made with the Atomic Energy Board of the Union whereby the company will erect a plant for the extraction of uranium from accumulated and current slimes. It is estimated that this plant will be in operation during 1955. The entire capital cost of the plant will be financed from American and British sources, and it will therefore be unnecessary to call upon members to provide any of the finance required. The cost of the plant and ancillary requirements is estimated to be approximately £2,000,000. The price payable for the uranium produced will be related to the cost of production on a basis which will ensure the redemption of the entire cost of the plant plus interest during the period of production, and will leave a satisfactory margin of profit.

Oilfields in Natal ?

It is hoped that boring operations on a site in Natal about 7 miles from Dannhauser will soon reveal whether there are worth-while quantities of oil beneath the surface in that area. The Department of Geological Survey is spending £5000 in sinking a 2000ft borehole on the site. Assay reports have already revealed workable amounts of high-quality mineral oil in the area. Oil seepage was first discovered in a shaft of the Natal Navigation Collieries' property at a depth of 650ft. Samples of the clay were sent to the Fuel Research Institute, Pretoria, which reported that the clay contained a very high-quality natural oil and a fair amount of paraffin wax.

Progress of Vecor and Iscor

A record of progress is to be found in the annual reports of these two companies. In the case of the Vanderbijl Engineering Corporation, Ltd. (Vecor), the net profits for the year to June 30, 1953, have been more than trebled compared with the previous year, and amounted to £160,000. Sales were over 50 per cent higher. The Corporation is now in a stage of consolidation during which a gradual rather than a rapid improvement should be expected. The output from Iscor's works at Pretoria and Vanderbijl Park is expected to reach an annual rate of 1,300,000 tons of ingot steel by April this year. The policy of the Corporation is to supply South African consumers rather than to find clients overseas. The Corporation possesses iron ore reserves of approximately 50,000,000 tons at Thabazimbi and a reserve of between 15,000,000 and 200 million tons near Kimberley. An assured supply of ore and other necessary raw materials puts the Corporation in a better position than steel industries in most other countries.

Sulphuric Acid Production for Uranium Recovery

The recovery of uranium has given South Africa a new secondary industry—the production of sulphuric acid. The acid plays as important a part in the recovery of uranium as cyanide does in gold production. It is expected that the plants now being erected as part of the Union's uranium scheme will ultimately produce sufficient sulphuric acid for the country's indus-

trial purposes and perhaps a balance for export. Pyrites—the raw material for sulphuric acid production—is readily available as a by-product of mining operations, and is obtained from the residues of some of the gold and uranium plants. The pyrites are first concentrated by flotation, the concentrate being then roasted to liberate sulphur dioxide gas. This gas is, in turn, converted to sulphur trioxide by raising it to a high temperature in the presence of vanadium pentoxide. The sulphur trioxide is then absorbed in water to make sulphuric acid. The total output of sulphuric acid by the five plants provided for in the present programme will be in excess of 1000 tons a day. The operation of the additional plant required for the production of uranium and of sulphuric acid will create extra demands for electric power at a time when power stations are already operating at full capacity. The future of the new industry appears to be assured despite the possibility of the eventual introduction of new methods for the production of uranium eliminating the need for sulphuric acid. An important aspect in this connection is the use of the acid in producing fertilisers. For many years South African farmers have experienced an acute shortage of fertilisers as a result of a world shortage of sulphur. Superphosphates—obtained by treating raw phosphate rock with sulphuric acid—can be expected to be produced in increasing quantities once the new acid plants are in full operation.

Cork Growing

The potentialities of the Union as a cork-growing country are being actively explored by the Department of Forestry. The Union imports more than 1,750,000 lb of unprocessed cork every year and the demand is growing. It is estimated that there are between twenty and twenty-five areas in South Africa suitable for the growing of cork trees. At present, 74,000 trees, covering 600 morgen, are needed to make the Union independent of cork imports. The trees are said to thrive where there are orange trees and grow better in sandy soil than in clay or loam. According to an expert who has started a processing industry near Johannesburg the growing of such trees could serve a four-fold purpose. It would be the basis of a new industry, eliminate the imports of unprocessed cork, bring in an extra £60 per morgen to farmers and provide the much-needed shade for cattle grazing on the open veld. In addition, the 30ft roots of the cork tree would help to bind the soil. Cork growing, however, is a long-term enterprise. The first harvest of bark could only be collected after fifteen years—probably less in the Union—and the other harvests at seven-year intervals. Yields, however, increase as the trees grow, and the quality of the bark improves with each harvest. The Department of Forestry is to issue a bulletin on the subject.

Railway and Industrial Progress in Southern Rhodesia

The new marshalling yard at Mpopoma, just outside Buluwayo, is already making its influence felt. The congestion that occasionally occurs at Buluwayo is relieved by the new railway junction, which has fifty-three sets of tracks and sidings, and covers an area of 170 acres. The entire scheme, including the 14-mile deviation of the Buluwayo–Salisbury line, an adjustment of the Victoria Falls line, and a "chord" line to the south, will cost approximately £1,500,000. Engineers working on the Salisbury–Buluwayo deviation hope to have the line open for traffic early this year, when Buluwayo's level crossings will have become superfluous.

Nairobi is to have a £175,000 factory to produce steel doors and window frames for the East African market. The necessary plant and machinery have been ordered from Britain and are now awaiting shipment. The decision follows a twelve-months' study, carried out by the parent company, Ideal Casements, Ltd., representatives of which visited a local workshop to watch Africans at work, so that they could advise on the adaptation of production methods to meet East African standards. It is intended that the monthly production will at first be 250 tons, to be doubled if demand justifies it. It is expected that at least 200 Africans will be employed at the outset.

Continental Engineering News

(By Our Continental Correspondent)

A Large Building in Warsaw

A large building called the Palace of Culture and Science, is at present being erected in the central part of Warsaw. The structure encloses a space exceeding 1,000,000 cubic yards in extent and is composed of a central tower, two wings and a congress hall. The tower is about 720ft high and is founded on a reinforced concrete raft, 230ft by 230ft in extent and 23ft thick, with a structural steel frame weighing some 16,000 tons. The structural system of the wings, which are about 100ft high, consists of concrete floors cast between rolled steel joists resting on masonry walls. The congress hall is designed to accommodate 3500 seats, and is covered with a steel dome, 164ft in diameter. The building programme is scheduled over seventeen months and the site is highly mechanised, the plant including fourteen derricks, with a total capacity of 82 tons, the largest being 183ft high.

The Salime Hydro-Electric Scheme, Spain

Good progress is being made with the construction, in Asturias, of the Salime hydro-electric scheme. The principal structure of the scheme will be a concrete gravity dam 430ft in height with a concrete volume of some 900,000 cubic yards. The annual output of the Salime plant will be 350 million kWh, and construction will be completed during the course of 1954; the contractor is the Firm Agroman S.A.

Hydro-Electric Works in Algeria

According to a report issued by Electricité et Gaz d'Algérie, the total electricity production in 1952 in Algeria amounted to 705 million kWh (as compared with 666 million kWh produced in 1951), about 40 per cent of which was generated by hydro-electric power stations. The following plants have been recently completed: Oued Agriom, Ain-Temouchent, Foum el Gherza, Ain-Beida and Zebair (this latter only partially). On the Upper Djendjen constructional work now in progress includes a prestressed concrete multi-arch dam 275ft high, which will form a storage reservoir of some 325 million cubic yards capacity, supplying, first, a power station comprising two 9·4MW turbo-alternator sets. There will then be a diversion tunnel 8½ miles long and 12½ft in diameter, leading to a surge tower and a penstock excavated in the rock (with steel lining), and supplying the main power house, near the village of Ziama-Mansouria, which will be equipped with two 50MW turbo-alternator sets. There will be two outgoing transmission lines, one at 150kV and the other at 60kV. Works were started on this scheme in 1952 and are now in full swing. When completed the scheme will have an annual output of 840 million kWh.

The Lille Motorway, France

Works are now in progress for the construction of a motorway, which will link the Southern part of Lille with the National highways in the direction of Douai and Arras. The new motorway, which will be 23 miles long, consists of two carriageways and is designed for a speed of 100 m.p.h. The overall construction width amounts to 98ft. Parking facilities will be provided by lay-bys every 1650ft. Except for one bridge spanning the Upper Deule Canal, which will be some 165ft long, the bridges along the motorway will have a span not exceeding 100ft. Work on the new motorway started late in 1951 and is progressing satisfactorily; it is hoped that the Lille-Carvin section will be opened to traffic early this year.

The Zofu Bridge, Belgian Congo

An important bridge is now being built over the Lualaba River, in the Belgian Congo to carry the railway traffic of the Upper Congo-African Great Lakes Company as well as highway traffic. The main structure consists of two approach spans, 131ft long, eight 216ft spans over the non-navigable waterway and two spans over the navigable channel, each of 216ft. The total length of this steel bridge will thus be 2422ft. The bridge is of cantilever design, the main elements of the steel superstructure being fabricated of high tensile steel sections. The Zofu bridge is being erected by the Engema-Secomi Companies and the Société Batignolles in co-operation with the Ateliers de Construction de Jambes-Namur, for the steel superstructure.

Ancenis Suspension Bridge, France

A long span suspension bridge has recently been erected over the River Loire at Ancenis. The new bridge replaces an ancient bridge built over a century ago by the famous engineer Marc Séguin, and destroyed in 1940. The structure has an overall length of 1350ft. It consists of three spans of 285ft, 780ft and 285ft, respectively. The decking accommodates a roadway 19½ft wide and two footpaths, each 4ft 10in wide. The stiffening girders are Warren lattice trusses 13ft 7in high, which give sufficient rigidity for the bridge to be practically unaffected by dynamic loads due to wind. The suspension cables are carried on reinforced concrete portal frames.

The new Ancenis bridge was erected by the Baudin-Chateauneuf Company for the steel construction and the Limousin Company for the foundation work and towers. The Ancenis bridge is one of three longest suspension bridges in France.

Public Works in Greece

According to a report published by Mr. Kavgalakis, General Director of the Greek Public Works Ministry, during the period 1948–52, some 750 bridges of a total length of 32,000ft were permanently restored. Reconstruction and asphalt surfacing was carried out over a length of about 1600 miles of roads; heavy failures have been roughly repaired on the remaining 10,600 miles of the highway system and approximately 1400 miles of new roads have been opened. Wide use has been made of modern mechanical equipment in this work, during which numerous quality control tests were carried out at the Greek Materials Testing Laboratory. The total cost of construction of the works amounted to some 440,000 million drachmas, plus some 11,500,000 dollars paid for supplies from abroad.

A new four-year scheme has already been prepared for the period 1952–56, covering the reconstruction of destroyed bridges, and of another 900 miles of asphalt surfaced main highways, the opening of 800 miles of new roads of local importance and various other works.

Swedish Hydro-Electric Progress

A new hydro-electric installation of 50MW capacity having an annual output of 300 million kWh, was recently put in service at Krokströmen, on the Ljusnan River in the northern part of Sweden. The project cost some £2,750,000 to build, and belongs to the Kraft A.B. Gullspang-Munkfors. It will supply power to the three provinces of Central Sweden. When certain hydraulic works on some of the lakes of the catchment of the scheme are completed, the installed capacity will be increased to 75MW, with a corresponding annual output of about 470 million kWh.

In 1952 Swedish hydro-electric power stations produced some 20,000 million kWh. This figure, however, is estimated to be only one-third of the resources available in the country. The demand for electrical energy increases each year by about 1200 million kWh, and an annual increase of 1500 million kWh is forecast by 1957. To meet these requirements the programme of new construction includes a scheme being built at Stornorrfors, near Umea, in the Norrland Province. The annual output of this project will be 2200 million kWh, i.e. about 200 million kWh more than the output of the big Harspranget plant. The new Stornorrfors hydroelectric project will cost some £13,800,000, it is estimated.

PURCHASING OFFICERS' "MINIBITION."—The Purchasing Officers' Association has announced that it will hold its fifth miniature exhibition—or "Minibition"—at the Royal Hall, Harrogate, from September 30th to October 2nd.

Industrial and Labour Notes

European Steel Market

A report, published this week by the industry division of the United Nations Economic Commission for Europe, reviews the European steel market in 1953. It has been arranged in three main sections dealing with steel production trends, and the availability of raw materials; steel demand and the trend of exports, and the future outlook.

According to this report the production of crude steel in 1953 in Europe, excluding Russia, was to 75,067,000 metric tons, which was more than 7,000,000 tons below the output planned. The report says that last year the increase in steel production was particularly striking in the United Kingdom, the U.S.S.R. and the U.S.A., and that there were increases also in most of the smaller steel producing countries of Europe. In Belgium, France and Luxembourg, however, there were significant declines in steel output last year, and in Western Germany there was a drop of nearly 400,000 tons compared with 1952. The report adds that these countries, and also Italy, have "relatively large unused capacity for steel production," which, it is stated, is an indication of the declining demand. The report goes on to say that it would be fatal to draw the conclusion that production should be adjusted to meet a permanently low level of demand. It is suggested that the steel industry might do more itself to extend the demand for its products, particularly through market research and a reconsideration of certain of its pricing policies, especially in the export field. The problem of unused capacity, however, is held to be essentially the problem of demand in the steel consuming industries. While much has been done since the war to modernise and expand the steel industry in all Western European countries, the report says that "there is a real need for more and better directed investment" in steel-consuming industries with a view to raising output and increasing efficiency.

About steel prices, the report says that against the background of production trends it would have been reasonable to expect a general weakening of prices. The main effect, however, of the coming into operation of the High Authority of the European Coal and Steel Community appears to have been to try to resist this tendency, at least so far as published internal prices are concerned. It is pointed out in the report that export prices are clearly falling sharply, and although there is still, for several products, a gap between internal and external prices, it is being steadily narrowed. The extent of the fall in prices, the report continues, is some measure of the degree to which overseas buyers have been paying a scarcity price in the past. The "inevitable reaction is a period of price warfare which may well reach a point detrimental to the interests of the steel industry, since revenue per ton will be lost without necessarily attracting increased orders through lower prices."

Industrial Production and Costs

At the annual meeting of the Clydesdale and North of Scotland Bank, which was held in Glasgow on Wednesday of last week, the chairman, Sir Harold Yarrow, Bart, commented in his address on the rising trend in industrial production and also on the effect of increasing industrial costs. Sir Harold said that the past year had been one of fairly steady recovery from the reduced level of activity in 1952. Government policy in the last twelve months had removed a further long list of materials from control, and that increased freedom had undoubtedly been a factor in reducing the artificial conditions in the national economy and also in gradually easing the conduct of trade. In conjunction with the lower but, on the whole, steadier level of commodity prices, Sir Harold continued, it meant a lessening of pressure upon industrial finances. Moreover, lower prices indicated a freer flow of material supplies, and that in turn had contributed to the rising trend of industrial production.

Sir Harold went on to say, however, that there were no grounds for easy optimism, and that, in fact, there were grave dangers ahead if, as a nation, we failed to realise the changes now in progress in the economic sphere throughout the world. He then referred to the importance of exports and to American, German and Japanese competition, commenting that this country's prices, delivery dates and credit terms must not only be attractive to the buyer, but they must, by implication, be at least as favourable as those of our competitors. There were already definite indications, Sir Harold continued, that in some of those respects Britain was no longer holding her ground, and had indeed suffered loss of business through the diversion, for example, of heavy engineering and shipbuilding orders to firms elsewhere, especially in Germany. Nor, he thought, were foreign competitors slow to appreciate any disadvantages we imposed upon ourselves through unofficial strikes and other limitations upon production.

It seemed to indicate, Sir Harold added, a serious misconception of the realities of the economic position that at this time a general movement should be afoot to raise further our industrial costs. He could only ascribe that policy to the fact that wage increases had been more or less regularly secured year by year, and that manufacturers' order books were still on the whole comfortably full. But full order books, like full employment, carried their own dangers for the future if they resulted in constantly rising costs. If our prices were not competitive, a time would certainly come when replacement orders could not be secured. That time, Sir Harold suggested, was ominously near and in some cases had actually arrived. It was then surely unwise, to say the least, to speed its approach by our own deliberate action.

Overseas Trade

The Board of Trade has stated that exports of United Kingdom goods in January have been valued provisionally at £225,800,000, which was slightly above the December figure, but below the average for the fourth quarter of last year. Exports in January last year were valued at £217,700,000.

Imports in January have been valued at £282,500,000, which was about 2 per cent above the monthly average in the fourth quarter of last year and slightly above the monthly rate in the first half of 1953. With re-exports in January at £8,100,000, the excess of total imports over total exports was £48,600,000. Although this was nearly one-third above the average in the fourth quarter, it was well below the rate in the first half of last year.

Railway Freight Charges

The Minister of Transport and Civil Aviation, Mr. Lennox-Boyd, announced in the House of Commons last week that he had decided to accept the advice of the permanent members of the Transport Tribunal, and to authorise the British Transport Commission to increase freight charges. As from March 1st, therefore, there would be a 10 per cent addition to the railway freight, dock and canal charges now in operation, subject in the case of merchandise by freight train and perishable traffic by passenger train to a maximum of 10s. a ton.

The Minister said that he had considered carefully the representations made by the Association of British Chambers of Commerce (referred to in these notes in our issue of February 5th). The issues raised by the Association could not be dealt with, however, as part of a purely interim settlement of the Commission's pressing need for further revenue. The Minister added that he had considered also the representations made to him by Scottish interests. He felt that some relief from the extra burden imposed would be afforded to them by the limitation of the increase in railway freight rates generally by a maximum of 10s. a ton.

It will be recalled that in making its application for the increase, the British Transport Commission stated that, at the present level of rates and charges, the revenue in a full future year would fall short of the expenditure chargeable against it by about £25,000,000. Of that total prospective deficiency, the Commission claimed, about £23,000,000 would be attributable to British Railways treated as a separate activity. The increases for which authority was sought would, in a full year, produce additional revenue in the case of British Railways of about £23,000,000 and in the case of the docks and canals of about £1,500,000.

Coal Miners' Wages

The National Union of Mineworkers has informed the National Coal Board that a ballot of the mineworkers had confirmed the acceptance of the recent offer of wage increases for about 400,000 day wage employees. The increases amount to 7s. 6d. a week for surface and 8s. 6d. a week for underground workers, with proportionate increases for juveniles. It is understood that the increases are retrospective to January 18th.

The conditions of the agreement are that the National Coal Board and the National Union of Mineworkers shall jointly continue to intensify their efforts to bring about increased productivity in the industry. In particular, it is urged that all practicable measures should be taken to achieve a 2½ per cent increase in coal production in the current year. In addition, the executive committee of the union has undertaken to use its influence to secure the renewal of the agreement to work Saturday shifts in the pits, when the present agreement ends in April.

Non-Ferrous Metals

The Organisation for European Economic Co-operation has issued the report for 1953 of its non-ferrous metals committee, in which it is stated that, in general, the market in non-ferrous metals is returning to normal, with production and consumption coming into balance. Nickel is still an exception, the report says, for although the situation has eased it cannot yet be considered as satisfactory for any European country.

Compared with 1952, fluctuations both in the production and consumption of non-ferrous metals in 1953 were not considerable, except in the case of aluminium, which shows a marked increase of production. The report also says that the drop in non-ferrous metal prices during 1952 and the early part of last year did not stimulate demand. It was noted, however, that the relative stability of prices which became apparent in the second quarter of last year encouraged demand and raised consumption at least to the 1952 level, if not beyond.

Coal Production

Coal output increased last week to 4,576,500 tons, of which 4,409,900 tons came from the deep mines and 166,600 tons from opencast workings. The latest statistical statement prepared by the Ministry of Fuel and Power shows that in the first six weeks of this year the deep-mined tonnage has exceeded by about 15,000 tons the amount raised in the corresponding period of last year. There has been some decline, however, in opencast output, with the result that the total production in the first six weeks of the year amounted to 27,531,200 tons, compared with 27,570,400 tons in the corresponding weeks of 1953.

Mining manpower has increased slightly in recent weeks, and in the week ended February 6th, there were 708,400 wage earners on colliery books, of whom 291,700 were working at the face. Absenteeism in the same week is stated to have been 13·23 per cent, a figure very near to that recorded for the comparable week of 1953. Coal consumption, including the amounts taken by exports and bunkers, totalled 5,346,000 tons in the week ended February 6th, against 4,984,000 tons a year earlier. Total distributed stocks of coal on February 6th were 15,227,000 tons, or about 1,600,000 tons more than on the corresponding date last year.

Notes and Memoranda

Rail and Road

EDUCATION FOR AUTOMOBILE ENGINEERING.—The London and Home Counties Regional Advisory Council for Higher Technological Education, has issued a revised curriculum of the facilities in this area for the study of automobile engineering. Details of both full time and part time courses are given. Copies can be obtained, price 1s., post free, from the secretary of the above council at Tavistock House South, Tavistock Square, London, W.C.1.

B.R. EASTERN REGION NEW WORKS PROGRAMME.—Improvements under the Eastern Region new works programme recently authorised by the British Transport Commission amount in total to a value of more than £650,000. The new works include the establishment of a new central stores depot for the Eastern Region at Peterborough; a new central permanent way depot at Chesterton Junction, near Cambridge; and extended provision of second-class accommodation on the S.S. "Arnhem," operating on the Harwich-Hook of Holland route to the Continent.

FRENCH ELECTRIC LOCOMOTIVE PERFORMANCE.—We are informed by French Railways that a 2-D-2 electric locomotive, No. 5547, attached to the Paris–Sud–Ouest depot covered a distance of 31,357 miles in July, 1953, which is claimed to be a monthly mileage record. This performance was achieved under ordinary traffic conditions hauling trains Nos. 5 and 6 (the "Sud Express"), which have an average weight of 500 tons, and trains Nos. 31 and 32, which have average weights of 825 and 875 tons on different parts of the journey. All these trains run between Paris and Irun. The locomotive in question first went into service in August, 1942, and, by July 1, 1953, it had covered a total of 1,292,449 miles

NORTHERN LINE EXTENSIONS.—An announcement regarding the future of certain railway works which were planned prior to the war for the northern end of the Northern Line has been made by London Transport. It is pointed out that as part of the 1935/40 railway new works programme, it was intended before the war to extend the Northern Line beyond Edgware to Bushey Heath and also to electrify the section of line between Mill Hill East and Edgware. These works had to be deferred owing to the war, and it is now clear, from what is known of the intentions of planning authorities, that no further major housing development is intended in the area which would be served by the extension and electrification as originally proposed. There is no doubt that the amount of traffic which might arise in the foreseeable future in the area would be totally inadequate to justify the high construction and running costs of any major new railway facilities and London Transport has accordingly decided, with the concurrence of the British Transport Commission, that the works in question should be abandoned.

Air and Water

CONTAINER TRAFFIC.—We are informed by the International Cargo Handling Co-ordination Association that its next symposium will be held in the Salle Chaleil, 11, Avenue Hoche, Paris, 8, on March 15th. The papers to be read will be concerned with the handling of perishable cargoes in port and will include one by a member of the French Customs, who will deal with the attitude of the Customs authorities towards containers and pallets.

AMERICAN BUREAU OF SHIPPING.—At the annual meeting of the American Bureau of Shipping it was stated by the president, Mr. W. L. Green, that on January 1st 531 ships of 2,709,009 gross tons were under construction or contract under the survey of the Bureau. This total was about 20 per cent less than the total at January 1, 1953, which was 690 ships of 3,337,411 tons. Of the current building programme 169 ships of 1,874,662 tons were on order in shipyards outside the United States, and amounted to twice the tonnage under way in American yards. During 1953 a total of 498 ships of 1,425,707 gross tons were completed under the survey of the Bureau. Of the total, 424 ships of 712,070 tons were built in the United States and seventy-four ships of 713,637 tons in shipyards outside the United States.

Miscellanea

CONCRETE TILE MANUFACTURE.—A party of German architects, builders and economists is visiting this country to study the British concrete roofing tile industry generally and, in particular, to discuss the manufacture of tiles and the supply of tile-making machinery. Besides touring tile-making works the party will visit sites where concrete roofing tiles are being used.

NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING.—The National Institute of Agricultural Engineering, which is situated at Wrest Park, Silsoe, Beds, is to be open for inspection by visitors on Wednesday and Thursday, May 26th and 27th. Visitors will have the opportunity to see much of the current research, development and testing work which the Institute has in hand.

ERGONOMICS RESEARCH SOCIETY.—The fourth annual conference of the Ergonomics Research Society is to be held at Ashorne Hill, Leamington Spa, from Monday evening to Thursday morning, April 5th to 8th. The theme of the conference is "The Scientific Study of Human Work in Industry," and full details are available from Mr. K. F. H. Murrell, "Spinneys," Marlpit Lane, Redditch, Worcs.

HIGH-STRENGTH ALUMINIUM ALLOY.—We are informed by Daralum Castings, Ltd., Darlington, that a new aluminium casting alloy known as "Frontier 40–E," is now available for castings production. The alloy has no copper content and age hardens at room temperature to give the following mechanical properties:—Yield point, 13 tons per square inch; ultimate tensile strength, 16 tons per square inch; elongation, 5 per cent.

CORRUGATED CONCRETE SHELL ROOFS.—We have received from the Central Building Research Institute, Roorkee (U.P.), India, a bulletin with the above title, written by Dr. Billig, the Institute's director. A general account of the development and practical achievements of the corrugated shell or "ctesiphon" system of construction, which has been developed by Billig and de Waller, is given in the booklet, including several examples of design computations.

B.I.C.E.M.A.—We are informed by the British Internal Combustion Engine Manufacturers' Association (B.I.C.E.M.A.) that following the decision of the independent chairman, Sir Lynden Macassey, not to seek re-election, there will now be an elected chairman assisted by a director. The new chairman is Mr. W. Kenneth G. Allen, joint managing director of W. H. Allen, Sons and Co., Ltd., and the Council has appointed Mr. C. C. Malcolm Logan as director.

ALUMINIUM INFORMATION SHEET.—We have received from Foundry Services, Ltd., a copy of "Information Sheet No. 16," which is concerned with aluminium-silicon alloys, the principal alloy being to B.S. 1490–L.M.6. The information sheet, apart from recording the chemical composition and mechanical properties, gives casting characteristics, melting considerations and procedure, and also notes upon grain refinement, moulding technique, and gravity and pressure die casting.

ROYAL SHOW AT WINDSOR.—The Royal Agricultural Society has stated that about half the target of £7000, set for its appeal fund for the Royal Show at Windsor, has already been subscribed. This fund is required principally to meet the cost of reinstating the show ground and providing suitable water and electricity services up to the boundary of the ground. The Society, of course, meets the costs, estimated at more than £150,000, of the actual erection and staging of the show. The show, which will be held in July in Windsor Great Park, will occupy 151 acres.

MINIATURE OUTPUT PENTODE VALVE.—A miniature output pentode valve ("EL85"), with a low current consumption, has been introduced by Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2. It is a Noval-based valve intended for a.c. mains operation. The heater rating is 6·3V, 0·2A, and the maximum cathode current rating is 35mA. The "EL85" valve, with its anode dissipation of 6W, may be used as an a.f. output valve or as an r.f. amplifier up to 120 Mc/s. As a class "A" audio amplifier it gives an output of 2·8W when operated with an h.t. supply of 225V and an anode current of 26mA; as an r.f. amplifier, it will deliver 2W at 100 Mc/s.

TELEPHONE STATISTICS.—The General Post Office has stated that at the end of last year there were 6,121,014 telephones in use in Great Britain, an increase of more than 2,200,000 since 1946. There were 19,594 telephone circuits over 25 miles in length in use in the public network at the end of December, 1011 of them having been added during the preceding twelve months. In the year ended March 31, 1953, the number of effective local telephone calls totalled 3165 million, and there were 264 million trunk calls. There were 1,484,000 outgoing calls in the Continental services, and 79,000 outgoing calls were made on the international radio telephone service.

TIMBER IMPORTS.—The Timber Development Association says that timber to the value of nearly £164 million was shipped to over 100 seaports in the United Kingdom in 1952, and in the same year £360 worth of timber was brought into airports. From the official records of H.M. Customs and Excise, the Timber Development Association has produced a detailed analysis of these figures showing the quantities and values of every kind of timber to arrive at each port and giving comparative figures for 1938, which has been taken as a typical pre-war year. Copies of the analysis may be obtained from the Timber Development Association, 21, College Hill, London, E.C.4, price 1s.

CAREERS IN THE GAS INDUSTRY.—A booklet entitled "A Career in the Gas Industry" has been issued by the Gas Council. This booklet is intended for young men leaving school or university. It describes the many openings available and the opportunities for promotion for those who enter the industry, whether on the technical, scientific or administrative side. The booklet stresses that it is the policy of the industry to maintain its reputation as a good employer and to provide for its employees remuneration and conditions of service which are comparable with those offered by any other industry in the country. The various pupilage schemes are outlined for university graduates and for those leaving secondary or public schools.

STRUCTURAL HANDBOOK.—We have received from T.I. Aluminium, Ltd., a copy of a structural handbook, entitled *Simplified Principles of Design in Aluminium*, by J. B. Dwight, M.A., M.Sc. The book gives some physical and guaranteed mechanical properties of certain alloys before making general reference to factors of safety and tension members. Problems in the design of struts are generally noted and then consideration is given to various forms of struts such as single and double angle, single and double channel, I section and tubular section. The next section is concerned with such items as the local and lateral buckling of beams and is followed by a section dealing with connections and including tabular statements giving the allowable stresses for rivets and bolts. Tables give particulars of angles, channels, tees and I sections, while appendices deal with weight, the calculations of the properties of beaded sections, the loading on roofing sheet and the derivation of formulæ. Curves give the values of allowable stress for centrally loaded struts and another curve indicates the allowable stress for struts of a particular alloy under three conditions of loading. There are curves of local buckling, which give coefficient "M" for channels and I sections, and also graphs for obtaining constants for substitution in a formula concerned with the torsional buckling of channels in compression.

TONG LOADER FOR COAL MINES.—A tong loader has been developed by Mr. F. Poskett, manager of the Middleton Broom Colliery, near Leeds, for gathering cut and blown coal on Longwall faces. It consists of two side plates, 5ft long by 1ft high, hinged at one end to a wedge-shaped head, and connected by toggle bars to a central traction bar which runs freely through the wedge head. To the ends of this traction bar are connected the main and tail ropes of a double-drum haulage unit; the tail rope passing from the head end of the bar, round a return wheel at the end of the face, and back to the haulage. When the tail rope is pulled the arms close and the tongs are pulled into the loose coal. Upon reversal and pulling with the main rope, the arms are forced open by the toggle bars, collect all loose coal in their path and carry it to the delivery point. As at present designed, the loader gathers about 8 cwt of coal on each run, but the size can be adjusted to suit local conditions.

MR. JOSEPH LEWIS.—We regret to record the death, on February 9th, at a London hospital, of Mr. Joseph Lewis, who was sixty-nine and had retired from the position of joint general manager of the Marconi International Marine Communication Company, Ltd., in 1948. Mr. Lewis was born at Beddington, Surrey, and joined the Marconi Marine Company as a seagoing wireless operator in 1902. In 1905 he was transferred to the company's associate, Societe Anonyme International de Telegraphie sans Fil. He rejoined the Marconi Company in 1909 and became a member of the shore staff as assistant traffic manager a year later. Mr. Lewis held various positions within the company until his appointment as joint general manager of the Marconi International Marine Communication Company, Ltd., in 1935. In 1937 he was transferred to Marconi's Wireless Telegraph Company, Ltd., as assistant to the managing director. Later he again became joint general manager of the Marine Company and held that position until he retired.

Personal and Business

MR. D. D. HAWLEY has been appointed to the board of Hadfields, Ltd., Sheffield, as sales director.

MR. T. J. FIRBANK has been appointed representative in the Far East of F. Perkins, Ltd., Peterborough.

DAVID BROWN (AUSTRALASIA) PTY., Ltd., Sydney, has acquired a new factory at North Lidcombe, New South Wales.

KERRY'S (GREAT BRITAIN), Ltd., has opened a sales office at 87–89, Edmund Street, Birmingham, 3 (telephone, Central 2005).

SIDNEY-BARTON, Ltd., has changed its address to Field House, 15–25, Breams Buildings, London, E.C.4 (telephone, Chancery 9551).

THOMPSON BROTHERS (BILSTON), Ltd., has transferred its London office to 17, Surrey Street, Strand, W.C.2 (telephone, Covent Garden 1701).

MR. R. K. EVANS, A.C.G.I., A.M.I.Mech.E., has been appointed senior engineer on the staff of C. MacKechnie Jarvis and Partners, 34, Victoria Street, London, S.W.1.

EXACTOR, Ltd., 108, Park Street, London, W.1, states that Mr. A. E. Griffin has been appointed general sales manager in succession to Mr. H. I. Arnold, who has become sales director.

J. SAMUEL WHITE AND CO., Ltd., announces that Mr. A. Hoare has been succeeded as engineering manager by Mr. H. C. Shaw, who was assistant to the engineering manager of Cammell Laird and Co., Ltd.

THE ENGLISH ELECTRIC COMPANY, Ltd., announces that Mr. Leonard H. Short, the deputy general export manager, has been appointed to succeed Mr. H. S. Aspinall as general export manager of the company.

MR. G. E. H. HALL has been appointed general manager of Sheepbridge Stokes, Ltd., and British Van Der Horst, Ltd., Chesterfield. Mr. R. Gore has been appointed works manager of Sheepbridge Equipment, Ltd.

MR. JOSIAH ECCLES, M.I.C.E., deputy chairman (operations) of the British Electricity Authority, has been appointed a member of the Minister of Fuel and Power's scientific advisory council in succession to Sir John Hacking.

ROCKWELL MACHINE TOOL COMPANY, Ltd., Welsh Harp, Edgware Road, London, N.W.2, states that it has completed arrangements for the manufacture in this country of the "Beer" die polishing machine, formerly imported from Germany.

THE MERSEY DOCKS AND HARBOUR BOARD announces that Sir Rex Hodges, who has been general manager and secretary since 1941, will retire in March and will be succeeded by Mr. F. H. Cave, the present deputy general manager and secretary.

POWELL DUFFRYN, Ltd., and the Coppee Company (Great Britain), Ltd., announce the formation of a jointly owned subsidiary to be called Powell Duffryn-Coppee, Ltd. Its purpose is to provide means for co-operation between the two companies in securing contracts for the installation of Coppee coke oven plant in Great Britain and the Commonwealth.

British Patent Specifications

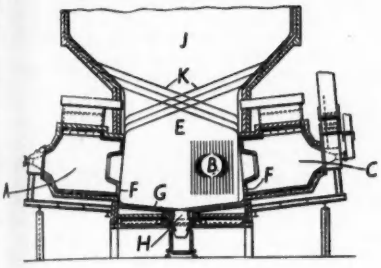
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

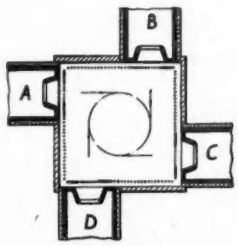
Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

STEAM GENERATORS

702,488. August 28, 1951.—COMBUSTION APPARATUS, Babcock and Wilcox, Ltd., Babcock House, Farringdon Street, London, E.C.4.

As shown in the drawings, four similar cyclone furnaces, *A*, *B*, *C* and *D*, having axes slightly inclined downward from the outer to the inner ends, discharge into a supplementary combustion chamber *E* of square cross section. They are tangential to a circle as shown. The slag outlets *F* from the cyclone furnaces open into the supplementary combustion chamber, the floor *G* of which slopes downwards to a central slag discharge opening *H*. The walls of the





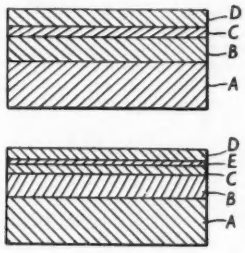
No. 702,488

cyclone furnaces are lined with vapour generating tubes of a steam boiler of which the combustion apparatus forms part of the floor and walls of the supplementary combustion chamber and the walls of a radiation chamber *J* above the chamber *E* are also lined with tubes. As is shown in the upper view, tubes from two opposed side walls of the supplementary combustion chamber *E* extend across the gas flow path from that chamber to the opposite side walls of the radiation chamber to form a tubular slag screen *K*. In operation, the cyclone furnaces discharge their flames or gases at high velocity into the supplementary combustion chamber, where the gases whirl around the vertical axis of the chamber. Such rotational movement effects an intimate mixing of the gases and thus accelerates combustion. Owing to the high speed of rotation, slag still contained in the gases is deposited by centrifugal force on the walls of the supplementary combustion chamber and flows down the walls and along the floor to the outlet aperture, where it is discharged, together with the slag flowing from the cyclone furnaces. Further slag is separated from the rotating and rising gases by the slag screen *K*, from which it finds its way to the floor. —*January* 20, 1954.

BEARINGS AND SUPPORTS

702,188. May 29, 1952.—PLAIN BEARINGS, The Glacier Metal Company, Ltd., 368, Ealing Road, Alperton, Wembley, Middlesex.

The invention relates to plain bearings, particularly steel-backed aluminium-lined bearings of the kind comprising electro-deposited overlay metals. The upper view in the drawing shows a cross section through a strip of bearing material which can be formed later into a bearing according to the invention, and the lower view the formation of a layer of copper-tin compound during use of the bearing at high temperature. The bearing comprises a steel back *A* to which is bonded a layer *B* of aluminium bearing alloy, a layer *C* of electro-deposited copper bonded to the aluminium alloy which has been subjected to preliminary treatment in conventional manner, and a layer *D* of electro-deposited tin or tin-base bearing alloy bonded to the copper layer. The steel back may be S.A.E. 1010 steel having a thickness of 0·10in. The aluminium bearing alloy layer may be an aluminium bearing alloy containing 6 per cent tin, 1 per cent copper, 1 per cent nickel and 1 per cent silicon, the balance being aluminium. The thickness of the layer *B* may be 0·020in. The electro-deposited copper layer *C* may have a thickness btweeen 0·0001in and 0·0005in, and is preferably about 0·0002in thick. The layer *D* may have a thickness between 0·0002in and 0·002in, and consist of electro-deposited pure tin or electro-deposited tin alloy containing up to 15 per cent of copper or up to 30 per cent of antimony, or up to 20 per cent of zinc, or any suitable combination of these alloying constituents, and up to 10 per cent of any suitable hardening constituent, such as nickel, the tin content being not less than 70 per cent. When used in an engine, the bearing will run well initially because of the excellent surface properties provided by the tin-base bearing material layer *D*. When the engine is first started, it will bear on high areas on the surface of the tin layer *D*. For a short time, these areas will be under a high load, but seizure will not take place because of the good surface pro-



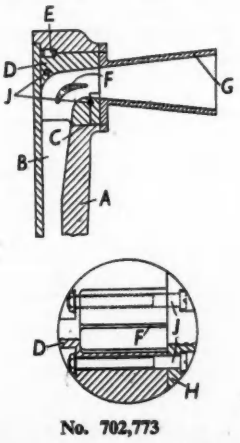
No. 702,188

perties of the tin. At the same time, the soft tin will wear away and be moved under the influence of the load until a much larger area is bearing the load. After the bearing has worn in and conformed due to some movement of the bearing as a whole, it will then function at high efficiency. After this has taken place, there will still be a tin layer present and this layer will have a relatively long life. During this period in which the tin is present, there is little danger of seizure at low clearances because of the presence of the soft metal. As the engine runs warm, a layer *E* of copper-tin compound will start to form between the tin layer *D* and the copper layer *C*. As this copper-tin compound layer thickens, its rate of formation will become slower, thus preventing excessive growth at engine temperatures. Eventually, the tin layer will wear through. The copper-tin layer will be exposed, but it will be broken up and embedded in the soft electro-deposited copper layer, and in the relatively soft aluminium bearing alloy layer. By this time the bearing will have conformed to the shaft, and be well worn in and the shaft will be well seated.—*January* 13, 1954.

COMPRESSORS AND BLOWERS

702,773. May 4, 1951.—CORNER VANE ELEMENTS FOR RADIAL FLOW COMPRESSORS, The English Electric Company, Ltd., Queens House, 28, Kingsway, London, W.C.2. (*Inventor: Adolf Frankel.*)

The invention relates to a corner vane element for the connection of two channels including an angle with one another, such as the diffuser channels of a radial flow compressor. As the drawing shows, the wall *A* in which the diffuser channels *B* are arranged, has cylindrical recesses *C* at the end of each channel. A cylindrical body *D* of a corner vane element is fitted into each recess *C* and restrained



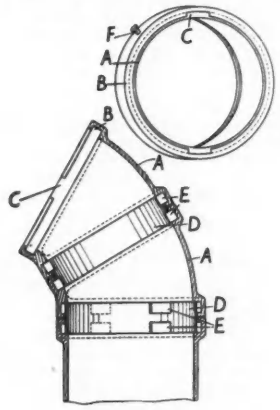
No. 702,773

from turning by a dowel pin *E*. A pair of angular ducts, separated from one another by a corner vane proper *F* of aerofoil profile, lead from the tangential direction of the diffuser channel *B* into a direction parallel to the rotor axis. A diffuser trumpet *G* is arranged at the outlet of these ducts. The cylindrical body *D* is split parallel to its axis so as to expose the wall surfaces of the ducts and of the corner vane laterally to facilitate manufacture. A segment *H* attached to the body *D* by means of two bolts *J* closes these ducts laterally and supplements the body to a complete cylinder. Preferably the split is located at one end of the corner vane proper and the closing segment has a flush face so that no matching-up between parts *D* and *H* is necessary. The ducts in the body *D* are of the usual substantially rectangular cross section and register at their inlet with the outlet of the associated tangential diffuser channel *B* in the wall *A*, and at their outlet with the diffuser trumpet *G*. Instead of a single corner vane two or more corner vanes may be provided in each cylindrical body of the corner vane element.—*January* 20, 1954.

TUBE AND PIPE COUPLINGS

702,741. March 14, 1950.—PIPE CONNECTIONS, The Miag Vertriebsgesellschaft m.b.H., of Braunschweig, Germany.

The invention concerns couplings, especially for connecting bend sections with straight portions of pipes or with other pipe bend sections. As will be seen from the drawing, the pipe bend sections *A* each have a curvature of 30 deg. and have grooves *B* machined behind their end faces. Axial slots or openings *C* provided at opposite points give access to the grooves *B* from the ends of the section. The connection of the sections *A* with one another is effected through annular connecting members *D* having lugs *E* at opposed points. These lugs are



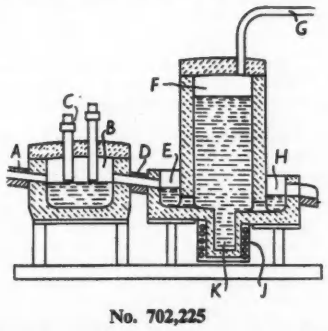
No. 702,741

received by the slots or openings *C* of the grooves. By rotation of the annular connecting members *D* and the pipe section *A* relative to one another a connection between the members is effected and at the same time the desired angle is obtained. To each pipe bend section straight pipes can also be connected in the same manner with the member *D* serving as a connecting means. The connecting member *D* can, when its position and that of the pipe sections have been fixed, be clamped by means of screws *F*. The bend sections are all of the same shape, are simple in construction and present no technical difficulties in casting. There is an infinite adjustment of inclination available since the bend sections and their connecting members can be rotated by any desired amount.—*January* 20, 1954.

METALLURGY

702,225. April 4, 1951.—THE MANUFACTURE OF STEEL, Frederic Barnes Waldron, 34, Albany Avenue, Eccleston Park, Prescot, Lancaster.

The invention is an addition to Specification No. 653,956, which relates to the process and apparatus for use in the manufacture of steel, and has for its



No. 702,225

object the removal of the gases which are dissolved or occluded or capable of being liberated from the steel while it is molten. The drawing shows a method of

carrying out the invention. The iron or steel which has been partially refined while flowing continuously through a series of furnaces flows along channel *A* into furnace *B* which is shown with electrodes *C* for an eccentric refining process on the metal. The metal flows thence continuously along channel *D* into hearth *E*. From this hearth it flows into the bottom of furnace *F* which is of sufficient height to allow the metal in it to rise an appreciable amount which may be 4ft or 5ft or more. The space above this metal is maintained at a vacuum which will cause the metal to rise. The pipe *G* connects through a cooler to a vacuum pump. An outlet at the bottom of the furnace connects to hearth *H* in which the metal is kept lower than that in hearth *E* by an amount chosen to ensure the required rate of flow through the furnace. One convenient method of heating the furnace is by means of coreless induction from an alternating electric current through coil *J* applied to a pocket in the bottom of the furnace as shown at *K*. The resultant agitation of the metal will assist in liberating the gases. Any other method of heating may be used.—*January* 13, 1954.

Technical Reports

Tracking in Solid Insulating Materials : Variables in the Test for Susceptibility to Tracking (Ref. A/T136). By V. E. Yarsley, W. J. Grant and G. C. Ives. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 24s., postage 5d.—The application of the method of test, described in Ref. L/T237, to a small range of insulating materials under conditions designed to allow statistical evaluation of the effect of several variables, has enabled recommendations to be made for improvements in the method of test. Comparison is made with similar work being done elsewhere.

The Dielectric Properties of Polytetrafluorethylene and Polychlortrifluorethylene (Ref. L/T275). By J. V. L. Parry (National Physical Laboratory). The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 6s., postage 3d.—The report describes an investigation of the electrical properties of polytetrafluorethylene (C_2F_4, known as P.T.F.E.) and polychlortrifluorethylene (C_2ClF_3, known as Kel F) over a wide range of frequency and temperature. The properties of the former are typical of a nonpolar material, whereas the latter exhibits dipolar properties, which is to be expected from the introduction of the chlorine atom into the structural unit. As is usual in dipolar solids, the low frequency absorption band in Kel F is broader than the simple Debye curve. The broad absorption is thought to be due to the influence of dipolar interaction in producing a variation in the heights of the potential barriers between equilibrium positions of the dipole. It is estimated from the results that this variation is of the order of 18 per cent. A feature of the results is the rapid increase of the maximum value of the power factor, with respect to change of frequency, as the temperature is increased. This is shown to be associated with a small increase in the value of the static permittivity with increase of temperature. The variation of the spread of relaxation times, and of the maximum value of power factor, with temperature, is shown to be in excellent agreement with the extension of Debye's relations derived by Frohlich.

Flameproof Electrical Apparatus : Flanged Joints, 1in and ½in in Radial Breadth, in Mixtures of the Vapour of Methyl Ethyl Ketone and Air (Ref. G/T284). By T. J. A. Brown and N. Simpson. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 10s. 6d., postage 3d.—For explosive mixtures of the vapour of methyl ethyl ketone (M.E.K.) and air, ignited in a bronze sphere having horizontal equatorial flanges 1in in radial breadth, the most incendive internal mixture is that containing 4·5 per cent of M.E.K. vapour by volume. The most readily ignitible external mixture contains 3·7 per cent of M.E.K. vapour by volume. With this combination of internal and external mixtures the maximum experimental safe gap, M.E.S.G., on a criterion of $n=20$, $k=0{\cdot}001$in, is 0·033in, and the statistical maximum safe gap, reassessed, S.M.S.G. (R), is 0·027in.

When the flange breadth is reduced to ½in the most incendive internal mixture contains 4·6 per cent of M.E.K. vapour by volume, and the most readily ignitible contains 2·9 per cent of M.E.K. vapour by volume. The M.E.S.G. is then 0·030in and the S.M.S.G. (R) 0·023in. The effect of reducing the flange breadth from 1in to ½in. is to reduce the M.E.S.G. from 0·033in to 0·030in, i.e. by 9 per cent : the S.M.S.G. (R) is reduced from 0·027in. to 0·023in, i.e. by 15 per cent.

Effects of Contamination on Structure and Properties, with Special Reference to Long-Chain Ketones. (Ref. L/T 281). By V. Daniel, Ph.D., F.Inst.P, and C. Turner, Ph.D. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 6s., postage 3d.—In E.R.A. report Ref. L/T249 it was shown that for pure ketones the dielectric constant changes discontinuously at the melting point, from a low value, characteristic of the solid, to a high one, characteristic for the liquid. The gradual transition from solid to liquid, which was found by Muller, is due to impurities.

The large effect of small amounts of impurities on the dielectric properties of ketones raises the question why these materials are so sensitive to contamination. The present report shows that impurities have no appreciable effect on the solid structure of the materials in question. However, the impurity effects can be understood in terms of the physical chemistry of mixtures. Ketones, as solvents of impurities, are an example of a kind of behaviour which leads to large effects of contamination on dielectric properties.

Bitter Figures and Single Crystals of Nickel and Nickel-Iron. (Ref. N/T63.) By Professor L. F. Bates, F.R.S., and G. W. Wilson. The British Electrical and Allied Industries Research Association, Dorking Road, Leatherhead, Surrey. Price 24s., postage 5d.—This work was carried out to throw further light on the theoretical aspects of the domain concept and on the nature of the fundamental and subsidiary domain structures of the ferro-magnetic metals and their alloys.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases, the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

CLEVELAND INSTITUTION OF ENGINEERS

Mon., March 1st.—Scientific and Technical Institution, Corporation Road, Middlesbrough, "Some Starting Up and Operating Experiences at the Abbey Melting Shop of the Steel Company of Wales, Ltd.," A. J. Kesterton, 6.30 p.m.

ENGINEERS' GUILD

Tues., Feb. 23rd.—Imperial Hotel, Birmingham, "The Impact of Information on Industry," K. J. Ryder, 6.30 p.m.

INCORPORATED PLANT ENGINEERS

Mon., Feb. 22nd.—W. AND E. YORKSHIRE BRANCH : The University, Leeds, "Engineering Problems at the Esholt Sewage and By-Products Works of the Bradford Corporation," W. H. Hillier, 7.30 p.m.

Thurs., Feb. 25th.—SHEFFIELD AND DISTRICT BRANCH : Grand Hotel, Sheffield, "Training of Maintenance Personnel," C. King, 7.30 p.m.

Fri., Feb. 26th.—BIRMINGHAM BRANCH : Imperial Hotel, Temple Street, Birmingham, "Tacoma Bridge Failure," B. G. Ough ; "Fatigue Fractures," J. Lang, 7.30 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Sat., Feb. 20th.—BRISTOL AND W. OF ENGLAND BRANCH : Grand Hotel, Bristol, "Steel Foundry Process Control," S. L. Finch, 3 p.m.——E. MIDLANDS BRANCH : College of Technology and Commerce, Leicester, "Mechanical Aids in the Foundry," J. Blakiston, 6 p.m.

Wed., Feb. 24th.—LONDON BRANCH : Waldorf Hotel, Aldwych, W.C.2, "Propeller Manufacture," J. M. Langham, 7.30 p.m.——BIRMINGHAM BRANCH : James Watt Memorial Institute, Great Charles Street, Birmingham, 3, "Gases in Cast Iron, with Special Reference to Nitrogen," L. W. L. Smith, 7.15 p.m.

INSTITUTE OF FUEL

Tues., Feb. 23rd.—Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, "Carbonisation of Blends of Coals to Produce Metallurgical Coke," H. Bardgett, 5.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Fri., Feb. 26th.—JUNIOR LECTURE, MERSEYSIDE AND N.W. SECTION : Technical College, Bolton, "Launching of Ships," R. S. Hogg, 3 p.m.

INSTITUTE OF NAVIGATION

To-day, Feb. 19th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The Requirements for Marine Pilotage," L. W. Akerman and R. F. Hansford, 5 p.m.

INSTITUTE OF PETROLEUM

Mon., Feb. 22nd.—26, Portland Place, London, W.1, "Oil Production in the Nottinghamshire Oilfields," C. M. Adcock and R. K. Dickie, 5.30 p.m.

INSTITUTE OF WELDING

Thurs., Feb. 25th.—S. LONDON BRANCH : Wandsworth Technical College, East Hill, S.W.18, "The Influence of Arc Welding on Modern Engineering Design," K. K. Doherty, 7 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., Feb. 23rd.—RAILWAY MEETING : Great George Street, Westminster, London, S.W.1, "Railway Civil Engineering Practice in the United States," N. J. Nicholls and I. M. Campbell, 5.30 p.m.

Wed., Feb. 24th.—N.W. ASSOCIATION : 9, The Temple, 24, Dale Street, Liverpool, "Piles, Pile Structures and Foundations," S. A. Paris, 6 p.m.

Fri., Feb. 26th.—YORKSHIRE ASSOCIATION : Blue Bell Hotel, Scunthorpe, "Reconstruction of a Soaking Pit Building," H. C. Husband and K. H. Best, 6.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

Mon., Feb. 22nd.—RADIO SECTION : Savoy Place, London, W.C.2, Discussion on "Acceptable Standards of Quality in Sound Broadcast Transmission and Reception," opened by J. K. Webb, 5.30 p.m.

Tues., Feb. 23rd.—MEASUREMENTS AND SUPPLY SECTIONS : Savoy Place, London, W.C.2, "Some Applications of the Electrolytic Tank to Engineering Design Problems," H. Diggle and E. R. Hartill, 5.30 p.m.

Wed., Feb. 24th.—SUPPLY SECTION : Savoy Place, London, W.C.2, "The Transport, Preparation and Utilisation of Colliery Tailings at the Emile Huchet Power Station," R. Gibrat and F. Chenin, 5.30 p.m.——TEES-SIDE SUB-CENTRE STUDENTS' MEETING : Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Impulse Testing," M. Todd, 6.30 p.m.

Thurs., Feb. 25th.—Grosvenor House, Park Lane, London, W.1, Annual Dinner, 7 p.m.

Fri., Feb. 26th.—N.E. STUDENTS' SECTION : Grey Hall, King's College, Newcastle upon Tyne, "Arc Control in High-Voltage Air-Break Circuit Breakers," D. Legg, 6.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION

Thurs., Feb. 25th.—N.W. BRANCH : Engineers' Club, Albert Square, Manchester, "Testing of Metals with Mechanical Vibration," K. Entwistle, 7.30 p.m.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

Tues., Feb. 23rd.—39, Elmbank Crescent, Glasgow, "Steel Wire Ropes : Their Construction and Application," F. J. Hewitt, 6.45 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, Feb. 19th.—GENERAL MEETING : Storey's Gate, St. James's Park, London, S.W.1, "Production and Design," L. H. Leedham, 5.30 p.m.

Tues., Feb. 23rd.—EASTERN AND MIDLAND BRANCHES : College of Art and Technology, Rugby, "Some Practical Applications of Strain Gauges in Industry," J. R. Bryant, 6.30 p.m.——S. WALES BRANCH : Mackworth Hotel, Swansea, "The Cooling of Rolling Mill Drives," P. M. Moreton, 6 p.m.——BIRMINGHAM A.D. CENTRE : James Watt Memorial Institute, Great Charles Street, Birmingham, "Combustion in Compression-Ignition Oil Engines," S. J. Davies, 6.45 p.m.

Wed., Feb. 24th.—SOUTHERN BRANCH : R.A.E. Technical College, Farnborough, Hants, "Relaxation Methods : A Retrospect," Sir Richard Southwell, 7.30 p.m.——SOUTHERN BRANCH, GRADUATES' SECTION : Technical College, Brighton, "A Talk on Varied Engineering Experiences," F. C. Temple, 7 p.m.

Thurs., Feb. 25th.—YORKSHIRE BRANCH : George Hotel, Huddersfield, "Aspects of Industrial Gear Drives," F. J. Everest, 7 p.m.; also visit to Park Works of D. Brown and Sons, Ltd., Huddersfield, 2.30 p.m.——WESTERN A.D. CENTRE : Grand Hotel, Bristol, "The Application of Power Assistance to the Steering of Wheeled Vehicles," F. H. Heacock, 6.45 p.m.

Fri., Feb. 26th.—GENERAL MEETING, JAMES CLAYTON LECTURE : 1, Birdcage Walk, Westminster, London, S.W.1, "Nuclear Reactors and Power Production," Sir Christopher Hinton, 5.30 p.m.——N.E. BRANCH : Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Operation of a Marine Gas Turbine Under Sea Conditions," John Lamb and R. M. Duggan, 6.30 p.m.

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

Wed., Feb. 24th.—INFORMAL MEETING : Conference Room, 4th Floor, Waterloo Bridge House, London, S.E.1, "Post-War Developments in Call-Office Equipment," R. T. A. Dennison, 5 p.m.

INSTITUTION OF PRODUCTION ENGINEERS

Mon., Feb. 22nd.—MANCHESTER SECTION : Reynolds Hall, College of Technology, Sackville Street, Manchester, "Machine Tools," J. H. River, 7.15 p.m.

Tues., Feb. 23rd.—LUTON SECTION : Town Hall, Luton, "Optical Measurement," J. H. Hobbs, 7.15 p.m.

Wed., Feb. 24th.—COVENTRY SECTION : Geisha Café, Hertford Street, Coventry, Film Evening, 7 p.m.——CORNWALL SECTION : Technical College, Trevenson Park, Pool, Redruth, Film Evening, 7.15 p.m.——SHREWSBURY SECTION : Walker Technical College, Oakengates, Salop, "Modern Methods of Production of Agricultural Castings," G. W. Nicholls, 7.30 p.m.——WESTERN SECTION : Grand Hotel, Broad Street, Bristol, "Production in the Boot and Shoe Industry," J. H. Britton, 7.15 p.m.

Thurs., Feb. 25th.—S. WALES SECTION : S. Wales Institute of Engineers, Park Place, Cardiff, "Practical Gear Production," L. Westley Smith, 6.45 p.m.

Fri., Feb. 26th.—W. WALES SECTION : Mackworth Hotel, Swansea, "Machine Tools for Precision Work in the Clock and Watch Industry," H. Matthews, 7 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, Feb. 19th.—S.W. COUNTIES BRANCH : Duke of Cornwall Hotel, Plymouth, "Structural Engineering at Abbey Works, Margam," A. V. R. Hooker, 7 p.m.

Thurs., Feb. 25th.—SCOTTISH BRANCH : Elite Hotel, Edinburgh, "Some Problems in Foundation Engineering," Hugh B. Sutherland, 6 p.m.

Fri., Feb. 26th.—MIDLAND COUNTIES BRANCH : James Watt Memorial Institute, Great Charles Street, Birmingham, "A Method of Structural Analysis by Large-Scale Models," C. B. Brewington and J. W. Fortey, 6 p.m.

INSTITUTION OF WATER ENGINEERS

To-day, Feb. 19th.—S.E. SECTION AND LAND DRAINAGE Section Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1, "Some Examples of Hydraulic Scale Models," J. Allen, 2.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, Feb. 19th.—Townsend House, Greycoat Place, London, S.W.1, "The Design and Construction of Modern Gas Appliances," H. S. Walter, 7 p.m.

Mon., Feb. 22nd.—N.W. SECTION : Engineers' Club, Albert Square, Manchester, "Water Supply and Conservation," N. Brookes, 7.30 p.m.

Fri., Feb. 26th.—INFORMAL MEETING : Townsend House, Greycoat Place, London, S.W.1, "An Introduction to the Shell Moulding Process," A. S. Ladley, 7 p.m.

LIVERPOOL ENGINEERING SOCIETY

Wed., Feb. 24th.—24, Dale Street, Liverpool, "Piles, Pile Structures and Foundations," S. A. Paris, 6 p.m.

MANCHESTER ASSOCIATION OF ENGINEERS

To-day, Feb. 19th.—Engineers' Club, Albert Square, Manchester "Sound Absorption," F. G. Ewing, 6.45 p.m.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Fri., Feb. 26th.—Mining Institute, Newcastle upon Tyne, "Correlation of Model and Ship Trials of a Shallow-Draught Rhine Vessel," W. P. A. Van Lammeren and J. D. Van Manen, 6.15 p.m.

SOCIETY OF ENGINEERS

Thurs., Feb. 25th.—INFORMAL MEETING : 17, Victoria Street, London, S.W.1, "Gaseous Discharge Lighting," F. W. Davies, 5.30 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Tues., Feb. 23rd.—Manson House, Portland Place, London, W.1, "The Development of an Automatic Tare and Net Weighing and Filling Unit with Remote Indication and Recording," A. Kennaway and R. A. Lolley, 6.30 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

To-day, Feb. 19th.—39, Elmbank Crescent, Glasgow, "Notch Ductility of Quenched and Tempered Steels," S. Downs ; "Vertical Rolling Mills," J. A. Kilby and G. A. V. Russell, 6.15 p.m.